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[NATURE, Jan. 3, 1884.]

THE SUN MOTOR AND THE SUN'S TEMPERATURE.

THE annexed illustration represents a perspective view of a sun motor constructed by the writer and put in operation last summer. This mechanical device for utilizing the sun's radiant heat is the result of experiments conducted during a series of twenty years; a succession of experimental machines of similar general design, but varying in detail, having been built during that period. The leading feature of the sun motor is that of concentrating the radiant heat by means of a rectangular trough having a curved bottom lined on the inside with polished plates so arranged that they reflect the sun's rays toward a cylindrical heater placed longitudinally above the trough. This heater, it is scarcely necessary to state, contains the acting medium, steam or air, employed to transfer the solar energy to the motor; the transfer being effected by means of cylinders provided with pistons and valves resembling those of motive engines of the ordinary type. Practical engineers as well as scientists have demonstrated that solar energy cannot be rendered available for producing motive power, in consequence of the feebleness of solar radiation. The great cost of large reflectors, and the difficulty of producing accurate curvature on a large scale, besides the great amount of labor called for in preventing the polished surface from becoming tarnished, are objections which have been supposed to render direct solar energy practically useless for producing mechanical power.

The device under consideration overcomes the stated objections by very simple means, as will be seen by the following description. The bottom of the rectangular trough consists of straight wooden staves, supported by iron ribs of parabolic curvature secured to the sides of the trough. On these staves the reflecting plates, consisting of flat window glass silvered on the under side, are fastened. It will be readily understood that the method thus adopted for concentrating the radiant heat does not call for a structure of great accuracy, provided the wooden staves are secured to the iron ribs in such a position that the silvered plates attached to the same reflect the solar rays toward the heater. Fig. 2 represents a transverse section of the latter, part of the bottom of the trough and sections of the reflecting plates; the direct and reflected solar rays being indicated by vertical and diagonal lines.

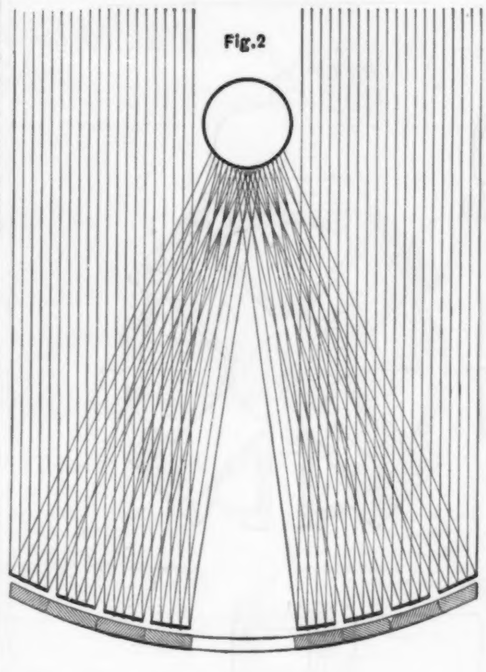
Referring to the illustration, it will be seen that the trough, 11 feet long and 16 feet broad, including a parallel opening in the bottom, 12 in. wide, is sustained by a light truss attached to each end; the heater being supported by vertical plates secured to the truss. The heater is 6¼ inches in diameter, 11 feet long, exposing $130 \times 9{\cdot}8 = 1{,}274$ superficial inches to the action of the reflected solar rays. The reflecting plates, each 3 inches wide and 26 inches long, intercept a sunbeam of $130 \times 180 = 23{,}400$ square in. section. The trough is supported by a central pivot round which it revolves. The change of inclination is effected by means of a horizontal axle—concealed by the trough—the entire mass being so accurately balanced that a pull of 5 pounds applied at the extremity enables a person to change the inclination or cause the whole to revolve. A single revolution of the motive engine develops more power than needed to turn the trough and regulate its inclination so as to face the sun during a day's operation.

The motor shown by the illustration is a steam engine, the working cylinder being 6 inches in diameter with 8 in. stroke. The piston rod, passing through the bottom of the cylinder, operates a force pump of 5 in. diameter. By means of an ordinary crosshead secured to the piston rod below the steam cylinder, and by ordinary connecting rods, motion is imparted to a crank shaft and fly wheel, applied at the top of the engine frame; the object of this arrangement being that of showing the capability of the engine to work either pumps or mills. It should be noticed that the flexible steam pipe employed to convey the steam to the engine, as well as the steam chamber attached to the upper end of the heater, have been excluded in the illustration. The average speed of the engine during the trials last summer was 120 turns per minute, the absolute pressure on the working piston being 35 lb. per square inch. The steam was worked expansively in the ratio of 1 to 3, with a nearly perfect vacuum kept up in the condenser inclosed in the pedestal which supports the engine frame.

In view of the foregoing, experts need not be told that the sun motor can be carried out on a sufficient scale to benefit very materially the sunburnt regions of our planet.

With reference to solar temperature, the power developed by the sun motor establishes relations between diffusion and

Fig. 2



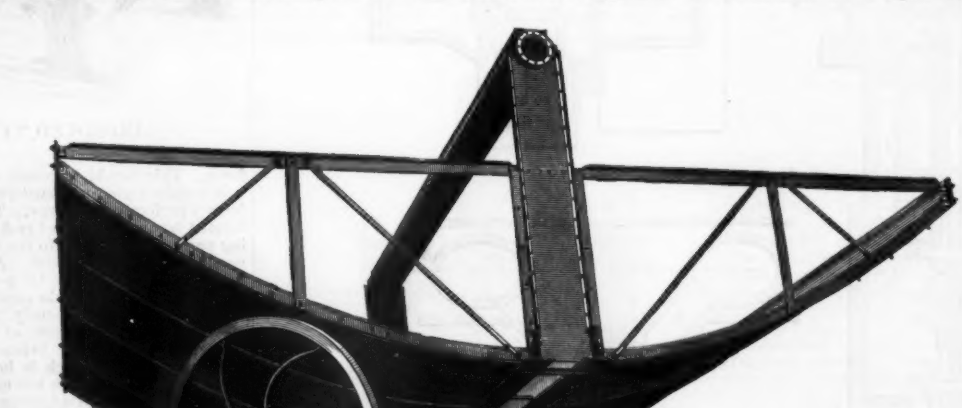
energy of solar radiation which show that Newton's estimate of solar temperature must be accepted.

The following demonstration, based on the foregoing particulars, will be readily comprehended. The area of a sphere whose radius is equal to the earth's mean distance from the sun being to the area of the latter as $214{\cdot}5^2:1$, while the reflector of the solar motor intercepts a sunbeam of 23,400 square inches section, it follows that the reflector will receive the heat developed by $\frac{23{,}400}{214{\cdot}5^2} = 0{\cdot}508$ square inch of the solar surface. Hence, as the heater of the motor contains 1,274 square inches, we establish the fact that the reflected solar rays acting on the same are *diffused* in the ratio of $1{,}274:0{\cdot}508 = 2{,}507:1$. Practice has now shown that, notwithstanding this extreme diffusion, the radiant energy transmitted to the reflector, by the sun, is capable of imparting a temperature to the heater of 520° F. above that of the atmosphere. The practical demonstration thus furnished by the sun motor enables us to determine with sufficient exactness the minimum temperature of the solar surface. It also enables us to prove that the calculations made by certain French scientists, indicating that solar temperature does not exceed the temperatures produced in the laboratory, are wholly erroneous. Had Pouillet known that solar radiation, after suffering a *two thousand five hundred and sevenfold* diffusion, retains a radiant energy of 520° F., he would not have asserted that the temperature of the solar surface is 1,760° C. Accepting Newton's law that "the temperature is as the density of the rays," the temperature imparted to the heater of the sun motor proves that the temperature of the solar surface cannot be less than $520° \times 2{,}507 = 1{,}303{,}640°$ F. Let us bear in mind that, while attempts have been made to establish a much lower temperature than Newton's estimate, no demonstration whatever has yet been produced tending to *prove* that the said law is unsound. On the contrary, the most careful investigations show that the temperature produced by radiant heat emanating from incandescent spherical bodies diminishes inversely as the *diffusion* of the heat rays. Again, the writer has proved by his vacuum actinometer, inclosed in a vessel maintained at a constant temperature during the observations, that for equal zenith distance the intensity of solar radiation at midsummer is 5·48° F. less than during the winter solstice. This diminution of the sun's radiant heat in aphelion, it will be found, corresponds within 0·40° of the temperature which Newton's law demands. It is proposed to discuss this branch of the subject more fully on a future occasion.

The operation of the sun motor, it will be well to add, furnishes another proof in support of Newton's assumption that the energy increases as the *density* of the rays. The foregoing explanation concerning the reflection of the rays—see Fig. 2—shows that no augmentation of temperature takes place during their transmission from the reflector to the heater. Yet we find that an increase of the number of reflecting plates increases proportionably the power of the motor. Considering that the parallelism of the rays absolutely prevents augmentation of temperature during the transmission, it will be asked: What causes the observed increase of mechanical power? Obviously, the energy produced by the increased *density* of the rays acting on the heater. The truth of the Newtonian doctrine, that the energy increases as the density of the rays, has thus been verified by a practical test which cannot be questioned.

It is scarcely necessary to observe that our computation of temperature — 1,303,640° Fah.—does not show maximum solar intensity, the following points, besides atmospheric absorption, not having been considered: (1) The diminution of energy attending the passage of the heat rays through the substance of the reflecting plates; (2) the diminution consequent on the great amount of heat radiated by the blackened surface of the heater; (3) the diminution of temperature in the heater caused by convection.

J. ERICSSON.



ERICSSON'S SUN MOTOR, ERECTED AT NEW YORK, 1883.

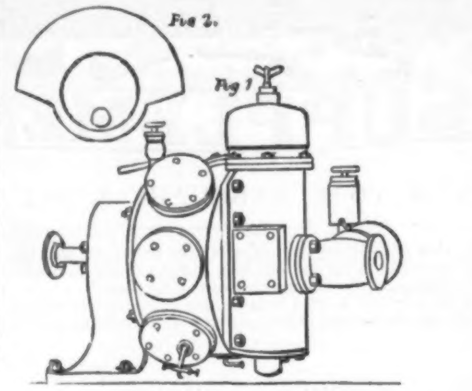
THE INTERNATIONAL EXHIBITION AT NICE.

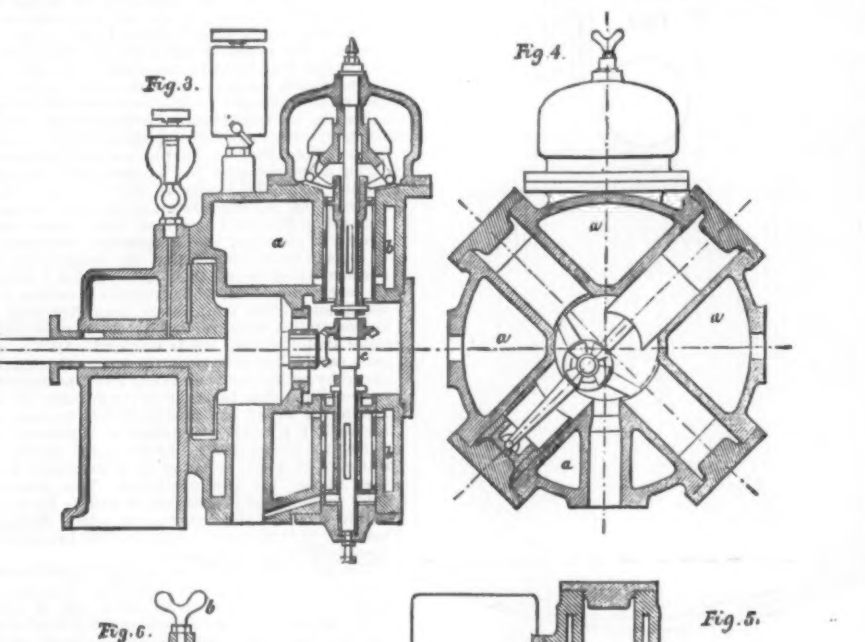
WE give, on page 6735, an engraving of the International Exhibition buildings at Nice, France, announced to be opened on December 24, 1883.

It would be difficult to select a more attractive location for a winter exhibition than the city of Nice, in the south of France. The town occupies an undulating plain in a recess of the mountains which form a protecting barrier to the bleak northerly winds. Here, overlooking the blue Mediterranean, is Nice, with its balmy air and orange trees flowering in mid-winter—a veritable land of delight. Of the exhibition, which is very extensive, we shall have occasion to speak hereafter. Our engraving is from the London *Graphic*.

THE ABRAHAM FOUR CYLINDER ENGINE.

THIS machine appears, says *Engineering*, to be meeting with successful application on the Continent, and is especially designed for developing a relatively high power where space is very limited. Fig. 1 is an outside view of the motor, which has four cylinders, and is single acting. These cylinders are placed at angles of 90°, and consequently are in two pairs diametrically opposite one another; the pistons are connected by two rings to a balanced crank pin (Fig. 2). These pistons are very long; they receive the steam pressure from behind, and are so arranged that all parts work in compression. In front of the four cylinders is placed the steam distributing apparatus. The body of the engine is cast in one piece, and between the cylinders spaces are left, to which the steam has access, so that they are steamjacketed. In the vertical steam distributing cylinder are the rotary valves, *o* (Figs. 3 and 6), the spindle of which engages with the main shaft by means of conical gearing, which gives it one-half the speed of the latter. These valves are placed at the ends of the spindle, *e*, and each of them controls the distribution of steam to two cylinders. As will be seen from the drawings, the valves are driven by means of keys, *f*, in the spindle, but they are free to rise and fall. The two valves are connected by a rod and the keys, *h*. At the upper end of the valve spindle is placed the regulator, which consists of two weights carried by the bent levers, the longer arms of which are attached direct to the upper valve. In addition to the weight of these pieces a spring, placed between the upper valve and the body of the regulator, acts upon the latter. by the openings, *n*. A development of the exterior of one of the valves is clearly shown in Fig. 8; internally they are divided by four partitions. The spaces, *o*, always receive steam by *m*, which flows into the valves by the openings, *q*; *r* are the exhaust ports. The steam is discharged through the spaces, *p*. The ports in the distributing cylinder are





THE ABRAHAM FOUR CYLINDER ENGINE.

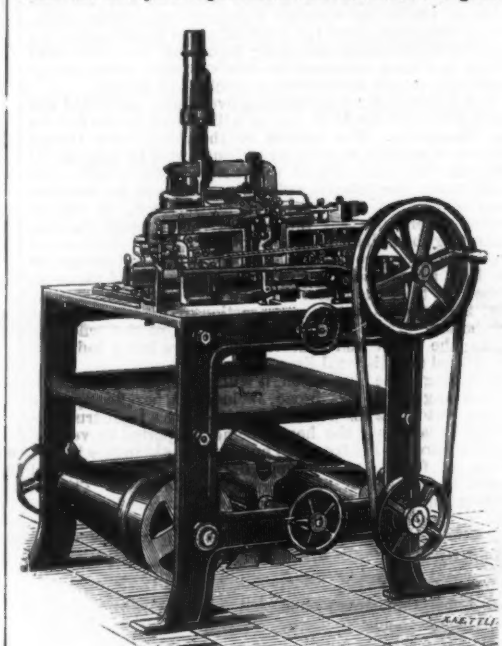
The tension of this spring is regulated at pleasure by means of a fly nut placed at the top of the box, and in this way the number of revolutions of the machine between considerable limits may be adjusted. The steam passages are shown in Fig. 6. Their section is rectangular, and large in reference to the very short periods of steam admission. The ports in the steam distribution cylinders are right angled triangles in form, the sides inclosing the right angle being vertical and horizontal. In each distribution cylinder there are two ports diametrically opposite, but not in the same level. The steam is admitted by the annular opening, *m*, and enters the valves larger than the corresponding ones in the valves. In working, the two valves, being connected, move together; the ports slide one over the other, and the lead remains always uniform, since the vertical sides do not change, and the periods of admission are modified by shifting the hypothenuse. The conditions of exhaust are uniform for all positions of the regulator. As the valves have a speed of revolution only one-half that of the driving shaft, there are always two openings, *q* and *r*, diametrically opposite, which exactly balance the valve. At the Vienna Exhibition, an Abraham motor was in daily work, driving direct a Schuckert machine which supplied a locomotive lamp of the Sedlaczek-Wikulill type. Three other similar engines were also exhibited, but not in motion. The following are some of the leading dimensions, etc., of the Abraham motors:

No.	Diameter of Cylinders.	Stroke.	Number of Revolutions.	Actual Horse Power with Pounds Pressure per Square Inch.				Weight.
				90	75	60	45	
	In.	In.						Lb.
1	2·17	2·28	960	4·1	3·4	2·7	2·0	220
2	2·76	2·76	800	6·6	5·5	4·4	3·3	374
3	3·54	3·15	700	10·8	9·0	7·2	5·4	550
4	4·32	3·54	630	16·8	14·0	11·2	8·4	770
5	5·31	4·13	550	25·0	21·0	17·0	12·5	990

IMPROVED TYPE MACHINE.

THE illustration below represents a type casting and finishing machine, devised by Mr. John Mair Hepburn, of the Bauer'sche Giesserei, Frankfort on Main.

The various functions of this machine are to melt the metal, found the type, remove the break, rub, dress, and nick the type, and pass them perfectly finished on to a wooden lath placed to receive them, at the rate of about 120 per minute; At the back of the machine is the melting pot and piston, the latter forces the metal into the mould, which we will presently describe. The melting pot is constructed in such a manner that the piston occupies a place in its rear, the passage from it to the mould being an inclined plane, immediately below which the gas flame heating the melting pot is situated. Within the piston a conical valve is situated; this valve has a long stem which passes up the center of the piston and hangs from a cross pin somewhat higher than the level of the metal in the melting pot. The bottom of the piston contains the seating of the valve, which latter, being hollow, forms an air chamber and causes a rapid closing which throws a jet of liquid metal into the mould with great



IMPROVED TYPE MACHINE.

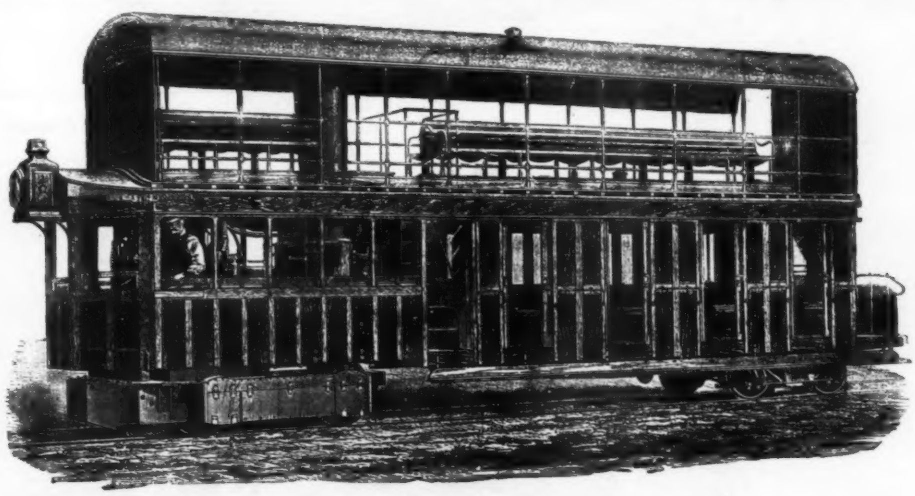
force. This mould is constructed in such a manner that it will remain rigid, and sustain enough internal pressure to form a perfectly solid type. The top and bottom sides are formed by two cheeks of cast steel hardened in their working parts, and attached to the frame of the machine by bolts passing through their sides. A steel slide is situated between these cheeks, and by its horizontal reciprocating movement pushes the types out of the mould and advances them through their first operation, namely, that of having the break removed. The opposite side of the mould to that formed by the center sliding piece before named is made of a vertical sliding side piece, which is held firmly against the vertical face of the mould (while the metal is being pumped into the latter) by an inclined plane on its opposite side which fits a corresponding plane, situated on the end of a horizontal slide, and fitting between the platform that receives the types. The vertical slide receives a reciprocating movement, and the horizontal one is fitted with a pressure spring and regulating screw; in this manner these two slides move in harmony, the one advancing to receive the type as it is pushed out of the mould in the same proportion as the other slide descends to allow of the type being pushed out. The matrix which forms the front of the mould is held in a steel box having a regulating screw on its top and side; by this arrangement the exact position of the matrix is determined, as the bottom and opposite side of the matrix box are acted upon by two suitable springs. The steel box with matrix is swung from its center vertically, and is moved to and from the side of the mould by a lever having an oscillating movement communicated to it by an inclined plane situated on the side of the lever. This gives the necessary motion to the vertical sliding side piece of mould as before described. The action of the center sliding piece of the mould, which is situated between the two cheeks before described, is regulated by an adjustable screw, which determines the exact thickness of the type, and passes through a block situated at the end of the mould. This block is mounted on a pivot, so as to allow of the center sliding piece of mould to be removed for cleaning or repairs. The simplicity of this automatic type founding machine over former machines is evident when it is remembered that it is not necessary to alter a single cam when casting a whole fount. The machine having been once adjusted to the thickness of the letter, all that is required is to set the nut situated on the regulating screw, just described,

as the thickness of the matrix determines the thickness of the type.

The types, after having been delivered by the center sliding piece of the mould on to the platform in the manner described, are passed from one set of cutters to another, which trim them on all sides. They are then delivered on to a wooden rail ready for use. The rubbing and dressing processes are thus effected by one cam only, acting direct on the pushers, and as this cam is firmly attached to the same shaft, which carries the cam operating the slides before named, all irregular working of the mechanism is precluded, besides which the whole machine is designed so that all parts are easily accessible, and any derangement can be observed and rectified at once.—*Engineering.*

STEAM CAR FOR STREET TRAMWAYS.

THE Baldwin Locomotive Works, of Philadelphia, have just completed an order from the Government of New South Wales, Australia, for a combined motor and car, of which we give engravings from the *Railroad Gazette*, for their street tramway service, built from a design submitted by Mr. Downe, the Superintendent of Motive Power of Steam Tramways in the city of Sydney.



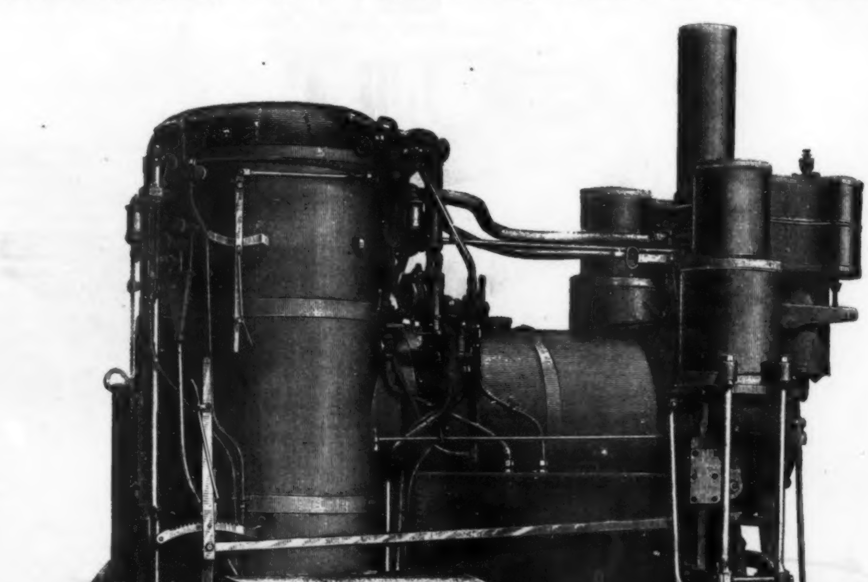
NEW STEAM CAR FOR STREET RAILROADS.

The car may be described as a combination of an ordinary tram-car with a motor of somewhat new design, in consequence of which, and the principle of engine adopted, an increased number of passengers are conveyed at a minimum expenditure of steam power. The car is divided into compartments, somewhat similar to those now in use in that city, with the exception that space is reserved at one end to receive the motor; and, with a view to lessen the chances of accident, passengers can only enter and leave the car on the side nearest the footpath. It is a double-decked car, the upper deck running the whole length of the car, and is accessible by means of two staircases, the entrance to which is on the same side as the lower compartments. The upper deck of the car is reserved for those wishing to smoke. When the engine is in position in the car no inconvenience can be experienced by outside passengers from heat, as the chimney is surrounded by an iron casing, extending the whole distance between the two roofs; the heat is thrown off above the level of the upper roof.

The motor is completely self-contained, all that is required after steam is raised being to move it into the car, lower the sole bars about one inch on to the bearing plate provided, connect the chimney, and couple the vacuum break tube; the car in front is then closed, all the machinery hidden, and the car is ready for work.

The motor consists of a substantial framing on which is mounted a steel boiler, with copper fire box of special design and ample capacity for supplying steam to a pair of compound engines working directly on the driving axle. The cylinders of these engines are fitted in what is known as the tandem form; a metallic stuffing box is fitted between the two the length of it, being the only distance separating the high and low pressure cylinders. Both pistons are attached to the same rod, and worked by the same crank; the valves are also a departure from the ordinary motor practice, they being of the piston type, and actuated by Joy's gear. The cylinders are supported on wrought-iron standards fixed on to the axle boxes, and they are also further supported on the smoke box end of the boiler; stays running from standard to standard and carrying the motion bars also assist in making the whole of the framework as rigid and substantial as is required, with the exception of a small safety link, to act in cases of emergency. It has been demonstrated in practice that no connection is necessary between the motor and the car beyond the resting of the latter on a suitable base in the former. Ample brake-power is provided with Eames' vacuum brake, so arranged that it can be applied to either engine or bogie, separately or combined. The cylinders are 9 in. and 12 in. diameter and 12 in. stroke. Driving wheels 2 ft. 6 in., wheel base 5 ft. 6 in. Steam pressure, 130 lb. to the square inch.

This car, which is 38 ft. long, including the spaces occupied by the engine, has a total wheel-base of 30 ft., and has been designed to carry 80 passengers, at a speed of 10 miles an hour on a gradient of 1 in 19, or 278 ft. to the mile. Apart from advantages that are expected in departing from the ordinary practice in the construction of the motor, a still further gain will be effected by the combination, for while the ordinary motor with an excessive load has only its own weight to rely on for adhesive force, this car, if so loaded, throws nearly half its live and dead weight upon the driving-wheels, thereby giving additional adhesion, and almost entirely overcoming the slipping usually experienced in starting an overloaded train. By the introduction of a change valve having 1⅜ in. travel, and worked by a lever, the driver can at will put all four cylinders in high pressure or compound while running. The advantage of this in a city having steep grades like Sydney will be fully appreciated, for should any difficulty be experienced in ascending, the driver, by simply changing the valves, has at once the power of two ordinary motors to overcome the grade, and the boiler has been made with increased heating surface to meet such an emergency.



NEW STEAM CAR FOR STREET RAILROADS.

This car has been designed with a view to comfort, safety, and economy.

The Commissioner of Railways in New South Wales having approved the design, the Government of that colony sent their Superintendent of Motive Power to this country to inspect this motor and car. Several tests have been made on the Philadelphia & Reading Railroad, the results of which are considered very satisfactory.

It has been forwarded by train to San Francisco, thence by mail steamer to Sydney, Mr. Downe accompanying it to make further tests of its efficiency on its own track. There is every probability, if the trials in Sydney confirm those made here, of its being adopted as the standard type for that city.

H.M.S. IMPERIEUSE AND SOME OF THE NEWEST TYPES OF SHIPS OF THE BRITISH NAVY.

THE Imperieuse, which was launched or rather floated out of dock on Dec. 18, 1883, after having been christened by H.S.H. the Princess of Saxe-Weimar in the presence of the naval and military authorities, as well as a very large assemblage of spectators, is yet another new addition to the different styles of ironclad ships adopted by our Government. This novelty is neither so thickly armored, nor does she carry such heavy guns as those of the Inflexible school. The four revolving tables (one on each side, and one fore and aft on deck), on which are mounted four *barbette* guns on the Vavasseur principle, capable of taking a very extensive sweeping fire (carrying a distance of seven miles) give a peculiar feature to this latest innovation. Besides, the sides of the ship amidships are curved from the deck to one-third the way to the water-line in order to cause the enemy's shots to glance off.

The Imperieuse, like the Inflexible, is "brig-rigged," her tonnage is 7,390, and she carries sixteen heavy guns—being a striking contrast to her old and obsolete namesake, the wooden first-class frigate of 2,146 tons, with fifty guns.

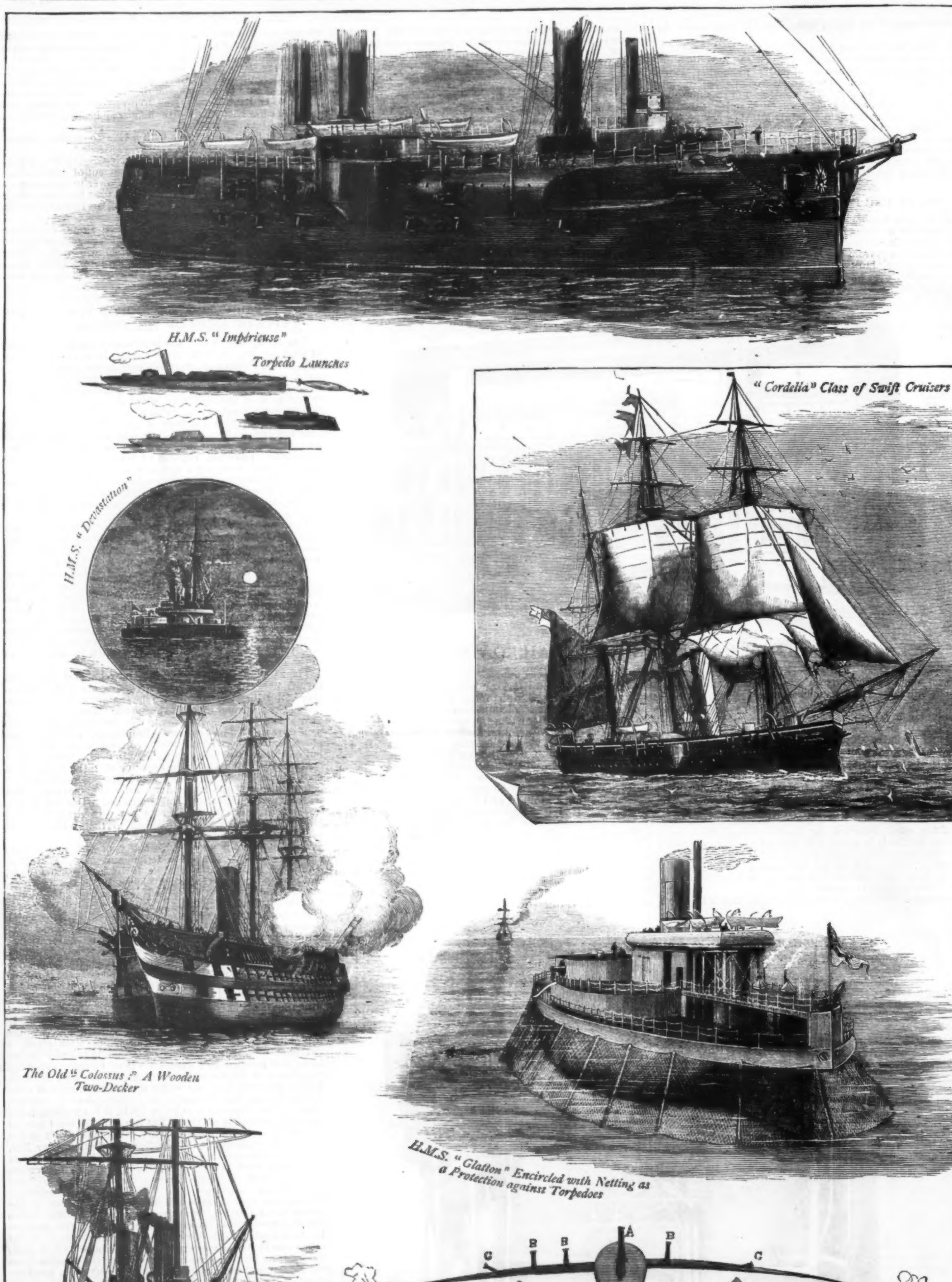
We now come to a more powerful vessel (Inflexible class, but with less tonnage). The Edinburgh is a sister ship to the Colossus, each having a tonnage of 9,150 and six guns, while the two remaining ships are the Ajax and the Alexandra, the tonnages respectively being 8,510 and 6,860. The last mentioned five vessels are supposed to be improvements upon the often-mentioned Italian specimens of ship-building, the Dandolo, Duilio, Italia, etc., which in most points in the hull they resemble.

The Edinburgh and the Colossus have but just concluded their trials, which, being very successful, are highly creditable both to the constructors and the engineers. The speed arrived at was beyond official expectation. The stability also proved satisfactory. In order to test the latter, about 600 men were drafted on board the Edinburgh, and were employed during the trial in running *en masse* from side to side, but only succeeded in inclining her 2¼ degs. There was a contra-agent employed in the experiment in the shape of a body of water (several tons) placed in the "water-chamber" below to arrest the momentum after the first roll. But whether much importance can be attached to this trial or not, it stands to reason that in a heavy sea with a strong wind blowing the result must be different to that which would occur in calm weather.

The Temeraire is another distinct type, with guns mounted *en barbette*. The Devastation and her sister ships, Thunderer and Dreadnought, again form a distinct class, and perhaps as powerful as any afloat, while the Cordelia, one of a fleet to which the Canada (Prince George of Wales' first ship) belongs, may justly be considered a specimen of a finely-modeled steam corvette, and capable of doing much damage with her long range, chase, and broadside guns. The former are protected by shields, and are, as in the Imperieuse, mounted on Vavasseur carriages placed on revolving tables. All the above-mentioned types are not the only representations of the changes which have taken place in the construction of the modern fighting ship in contradistinction to the "frigate and line-of-battle ship" of the past, but even the little gun boats have been revolutionized. Now we have small fragile iron steamboats carrying one or more guns in the bow and stern, protected in some instances only by thin iron shields, whereas in the old time hands were piped, a twelve-oared wooden boat lowered with a 12-pounder in the bows, and manned by a crew on whose muscles depended the success of the chase, aided by sails if the wind favored. Lastly, we come to a class which most of us trust will have to wait a long time before a trial takes place in earnest, namely, the "torpedo boat." In itself, it is harmless, being frail and possessing no ram. But it carries the most terrible weapon of war—the unseen enemy. We have dwelt as yet only on the vulnerability of our Navy above the water line, but what of the underneath part, which, as in the rhinoceros, is the truly weak point? Then there is the risk of coming in contact with the sunken mine, the "spar torpedo," and last, though not least, the "Whitehead fish torpedo." Precautions against these will be taken, as shown in the sketch of the Glatton, by means of a network girdle, which can be lowered from the deck, but at present little progress has been made in this direction. In the mean time, as far as torpedo boats are concerned, they will have before them the far from pleasing task of encountering the missiles from the Nordenfeldts and Gatlings, which could give a good account of their foes, even at night time, with the aid of the electric light. Some of the torpedo launches reach a speed of nineteen knots per hour.—*W. E. Atkins, in London Graphic.*

LIEBIG'S SOUP FOR INFANTS.

ACCORDING to Meffdorsky in the *Pharm. Zeitschr. f. Russ.*, this soup is best prepared in the following manner: Take 480 parts of ordinary fresh wheat flour (not the finest), 480 parts of malt flour, and 15 parts of carbonate of potash, and mix well. Add to this 960 parts of water and 4,800 of milk, and heat them slowly, stirring constantly until the mixture begins to get thick; then remove the pot from the fire, and stir five minutes. It is then heated again until it begins to thicken, is removed once more, and finally heated until it boils. The whole is then passed through a fine sieve which retains the bran of the malt flour. Soup prepared in this manner is sweet and requires no addition of sugar, and will keep for twenty-four hours.



H.M.S. "Impérieuse"

Torpedo Launches

H.M.S. "Devastation"

"Cordelia" Class of Swift Cruisers

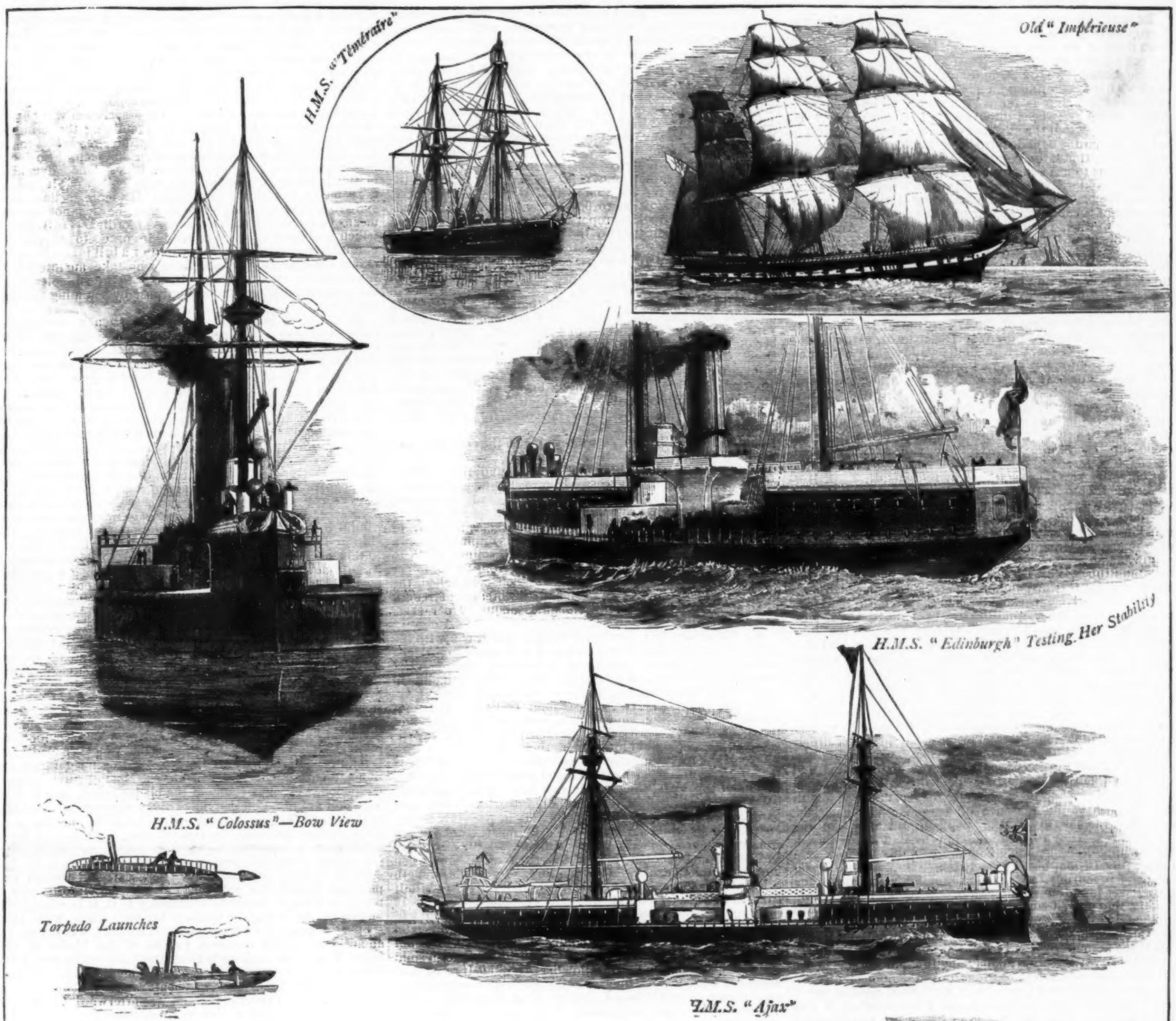
The Old "Colossus:" A Wooden Two-Decker

H.M.S. "Glatton" Encircled with Netting as a Protection against Torpedoes

H.M.S. "Impérieuse"—View of the Starboard Bow

H.M.S. "Impérieuse"—Deck Plan (A. Barbette Guns.—B. Broadside Guns.—C. Chase Guns.—D. Nordenfeldt Guns)

THE NEWEST TYPES OF SHIPS OF THE BRITISH NAVY.



THE NEWEST TYPES OF SHIPS OF THE BRITISH NAVY.

MANGANESE BRONZE.*

By Mr. P. M. PARSONS, M.I.C.E.

BEFORE entering on the immediate subject of this paper, I propose to give a brief description of what has previously been done in the same direction, and to review the theoretical considerations which have led to the production of manganese bronze. Many samples of bronze made by the ancients have been found on analysis to contain a small percentage of iron, but as far as I am aware, no traces of manganese have ever been discovered. It is not unlikely the ancients knew that the addition of iron to bronze would increase its hardness, and introduced it with that view. In more recent times, the combination of iron with the brass alloys seems to have engaged the attention of inventors considerably, and a few have also introduced manganese by reducing the black oxide, and combining it with the copper, but none of these alloys appear to have shown sufficient advantages to lead to their permanent adoption. Among the earliest of these inventors was James Kier, who as far back as the year 1779 proposed an alloy of 10 parts of iron with 100 of copper and 75 of zinc. Alloys of a similar character to this, but containing less iron and different proportions of copper and zinc, were subsequently introduced under the name of sterro metal and Aitch metal, and Sir John Anderson, late superintendent of the Royal Gun Factories and inspector of machinery to the War Department, carried out a number of experiments with similar alloys, and with some very good results, but no practicable applications of any of them appear to have been made. The addition of iron unquestionably increased the strength and hardness of these alloys, but the experiments I have made show that they acquire these qualities at the expense of ductility and toughness, and it is probably on this account that they have not come into general use. Besides these, various other inventors have proposed to combine iron with the brass alloys, but only Mr. Alexander Parkes and the late Mr. J. D. Morris Stirling, both eminent metallurgists, proposed the use of manganese, and appear to have carried their ideas into practice. Mr. Parkes' inventions consisted in combining manganese alone with copper, and using this alloy instead of ordinary copper with zinc to form improved alloys of brass, yellow metal, etc., of which to make sheathing, rods, wire, nails, and tubes, etc. Mr. Everitt, of Birmingham, has also lately brought forward an alloy made in a similar manner.

No comparative experiments as to the strength, hardness, or ductility or other qualities of these alloys have come under my notice, but I believe the only effect of the manganese alone is to add somewhat to the toughness and ductility of the alloys, and allow copper and zinc, of a somewhat inferior quality, to be used in the manufacture of brass and other similar alloys, which without the manganese would not stand the working necessary to shape them into the various articles for which they were destined. Mr. Morris Stirling, in 1848, however, proposed to use manganese in various brass alloys, in which iron was present, but in a very different manner from that employed by me. Mr Stirling first combined about 7 per cent. or less of iron with the zinc, and added to the copper a small percentage of manganese, by reducing the black oxide of manganese with the copper, in the presence of carbonaceous materials, and then added to it the requisite quantity of the iron and zinc alloy to make the improved brass required. Mr. Stirling described a method of combining the iron with the zinc by fusion, but in practice he found a more ready means of procuring the zinc and iron alloy by employing the deposit found at the bottom of the tanks used for containing the melted zinc for galvanizing iron articles; this product consists of zinc with from 4 to 6 per cent. of iron, but this percentage is very variable, and this material is useless if the amount of iron is required to be adjusted with accuracy. A variety of metal made by this process was in use for some time for carriage bearings, on the London and North-Western Railway and others, with very good results; but it has long since been superseded, and I feel satisfied it was never introduced for any purposes where the requirements were great strength, hardness, ductility, etc., which may be partly accounted for by the defect which all these alloys possess in common, viz., the great difficulty of producing sound castings of them in sand moulds with any certainty.

These, then, were the chief inventions that have come under my notice at all approaching mine in character or similarity, at the time I introduced it, and which I will now proceed to describe. The manganese bronze is prepared by introducing and mixing with the copper (to be afterward made into alloys, similar to gun metal, bronze, brass, or any other alloy of which copper forms the base) a small proportion of ferro-manganese. The ferro-manganese is melted in a separate crucible, and is added to the copper when in a melted state, and at a sufficiently high temperature. The effect of this combination is similar to that produced by the addition of ferro-manganese to the decarburized iron in a Bessemer converter; the manganese in a metallic state having a great affinity for oxygen, cleanses the copper of any oxides it may contain, by combining with them and rising to the surface, in the form of slag, which renders the metal dense and homogeneous. A portion of the manganese is utilized in this manner, and the remainder, with the iron, becomes permanently combined with the copper, and plays an important part in improving and modifying the quality of the bronze and brass alloys, afterward prepared from the copper thus treated, the effect being greatly to increase their strength, hardness, and toughness, the degrees of all of which can be modified at will, according to the quantity of the ferro-manganese used, and the proportions of the iron and manganese it contains. By these variations, together with variation in the proportion of copper, tin, and zinc employed, a most valuable range of new alloys has been produced, possessing qualities in the way of strength, hardness, and toughness, etc., far beyond anything yet obtained in any similar alloys. It will be seen that the process described of making the manganese bronze is altogether different, both in principle and effect, from Stirling's or Parkes' inventions. By Stirling's method, combining the iron with the zinc, in order to introduce it into the alloys, altogether precludes its use in any but those alloys in which a considerable portion of zinc is employed, such as brass or yellow metal. It could not be applied to any of those important alloys, of the nature of gun metal, or bronze, in which copper and tin are the chief ingredients, and which form some of the most important qualities of the manganese bronze; but an equally important difference in the manufacture of manganese bronze consists in adding the manganese in its metallic state, in the form of ferro-manganese, to the copper, by which the copper is cleansed from oxides as before explained, which can never be the case when the manganese is reduced from the black oxide and combined with the copper by one and the same operation, in the manner pursued by Parkes and Stirling.

Another point of great importance is the very great nicety with which both the iron and manganese can be adjusted, and the effect controlled by adding the ferro-manganese to the copper, as pursued in the manufacture of manganese bronze. The amount of manganese required for deoxidizing the copper, and for permanent combination with it, having been ascertained by experience, it is found that very slight variations in quantity have a perceptible and ascertained effect in modifying the qualities of the alloys produced; that is to say, the toughness can be increased, and the hardness diminished, or *vice versa*, at will, precisely as is done in the manufacture of steel, by increasing or diminishing the dose of carbon and manganese. In preparing the ferro-manganese for use, that which is rich in manganese, containing, say, from 50 to 60 per cent., is preferred; this is melted with a certain proportion of the best wrought-iron scrap, so as to bring down the manganese to the various proportions required. About four qualities are made, containing from about 10 to 40 per cent. of metallic manganese. The lower qualities are used for those copper alloys in which the zinc exceeds that of the tin, and the higher qualities in which tin is used alone, or exceeds that of the zinc used in combination; and the amount of ferro-manganese added varies generally from about 2 to 4 per cent. After a number of experiments and tests, the Manganese Bronze and Brass Company, who are the sole manufacturers of the manganese bronze, have adopted the manufacture of five different qualities of manganese bronze, although other varieties can be produced for special purposes. The distinctive features, peculiarities, and purposes for which these qualities are suited are as follows:

1. In this quality the zinc alloyed with the copper is considerably in excess of the tin.

It is cast into ingots in metal moulds, and then forged, rolled, or worked hot, and made into rods, plates, sheets, sheathing, and it may also be worked cold, and drawn into tubes, wire, etc. When simply cast it has a tensile strength of about 24 tons per square inch, with an elastic limit of from 14 to 15 tons. When rolled into rods or plates it has a tensile strength of from 28 to 32 tons, with a limit of 15 to 23 tons per square inch, and it stretches from 20 to 45 per cent. of its length before breaking. When cold rolled, the elastic limit rises to over 30 tons and the breaking strength to about 40 tons, and it still elongates about 12 per cent. before breaking.

No. 2 is similar to 1, but still stronger, and it can, with the required care, be cast in sand when it is required to produce castings for special purposes, possessing the greatest strength, hardness, and toughness, but it must be melted in crucibles; passing it through the reverberatory furnace injures the metal, and causes unsound castings. It is not therefore adapted for general brassfounders' purposes, and those only who understand its peculiarities, and are experienced in its use, should attempt casting it in sand.

One of the most important applications of this quality is that of producing articles cast in metal moulds under pressure. Blocks of this metal thus simply cast have all the characteristics of forged steel, as regards strength, toughness, and hardness, without any of its defects. It is perfectly homogeneous, and, while not possessing a fibrous texture derived from rolling or hammering, it is still fibrous in character, and this in not one but in all directions alike, and when broken shows a beautiful silky fracture. Its tensile strength is from 32 to 35 tons per square inch, and its elastic limit from 16 to 22 tons, with an ultimate elongation of from 12 to 22 per cent. It can be cast on to any object, and will shrink on to it with a force equal to its elastic limit, and when released will show an amount of resilience of about double that of steel. Thus a hoop, shrunk on to a solid cylinder of iron, gave the following results: It stretched when hot 0·03 of its diameter, in the process of contraction, and when cold and released sprang back about 0·003 of its diameter. As regards hardness, it is about equal to mild steel. To ascertain its efficiency in this respect, and to compare it with gun metal, wrought iron, and steel, the following tests were made, by forcing a knife edged angular die into the flat surface of each of these metals, and the No. 2 manganese bronze cast under pressure. To make a dent of equal length in each of these, the following pressures were recorded:

Gun metal	12	cwt
Wrought iron	15	"
Mild steel	20	"
" oil hardened	25	"
Manganese bronze as cast	20	"
" " " hardened by pressure	22 to 23	"

All these results point to this material as a most suitable one for the construction of hydraulic and other cylinders, required to stand great strains, and particularly for ordnance. The Manganese Bronze and Brass Company are now making arrangements for casting a block in this metal to be made into a gun, and the results are being looked forward to with much interest, as, should this prove successful, the material is likely to become a formidable rival to steel and iron for the construction of artillery, as, although the metal itself is more costly, the simple way in which it can be manipulated will make the total cost less, and the time required to construct a gun of it will probably be less than one-fourth of that required to build up iron or steel guns.

3. This is an equally important alloy with the last, but possessing altogether different qualities, and suited to different and more varied applications.

It is composed principally of copper and tin, in about the proportions of gun metal, combined with a considerable dose of ferro-manganese. Its chief characteristics are very great transverse strength, toughness, and hardness, the facility with which it can be cast, and the soundness and uniformity of the castings produced, without any special care having to be taken beyond what is ordinarily given in casting gun metal. It also possesses this very important advantage in the production of large castings, that it may be melted in an ordinary reverberatory furnace without injury to the metal; very careful analysis of this alloy before and after passing through the reverberatory furnace showing that there is no appreciable alteration in its constituents. A bar of this metal cast in sand in the ordinary way, one inch square placed on supports 12 inches apart, requires upward of 4,200 lb. to break it, and before breaking it will bend to a right angle, and it will sustain from 1,700 to 1,800 lb. before taking a permanent set. These results are in every respect fully up to those of the best rolled wrought iron, as some test bars of both exhibited will show; we have, therefore, in this a material which can be cast with facility into any intricate form, which it would not be possible to forge in iron, yet possessing all its strength, toughness, and hardness. This quality of manganese bronze is used for a variety of purposes, including spur, bevel, and all kinds of toothed wheels, gearing, worms, and worm wheels, framing brackets, and all kinds of supports and connections of machines, crank pin brasses, the shells of main and other bearings of marine and other engines, axle boxes, and other parts of locomotive engines, and it has been found admirably adapted for statuary and art purposes generally, being much admired for its fine color, but the latter quality is quite a matter of taste, and the members of the association will be able to form their opinion thereon by examining the beautiful clock and ornaments, kindly lent by Messrs. Elkington & Co., made of the manganese bronze. The metal also seems to be peculiarly adapted for large bells. The advantages in this latter application are that bells cast from it possess the same or greater sonorousness with a more mellow tone, and are at the same time so tough that they cannot by any means be cracked like bells made of ordinary bell metal, which is obliged to be made brittle in order to acquire the requisite sonorousness. The sound of a bell is also to some extent a matter of taste, and those who take an interest in this question may form an opinion as to the suitableness of the manganese bronze for this purpose by sounding the one exhibited.

But the most important application from a commercial point of view is undoubtedly that of steamship propellers. Owing to the great strength of this metal, and its non-liability to corrosion, propellers of it can be made thinner than even those of steel; the surface is beautifully smooth, and when cast they are theoretically true to form, whereas in steel propellers allowance has to be made against the corrosion which takes place, and their deficiency in toughness by increasing their thickness, and their form becomes distorted in the annealing oven they have to pass through after being cast. For these reasons the manganese bronze has a great advantage over steel. It has been proved conclusively by the logs of a number of steamships that have had their steel propellers replaced by manganese bronze blades that their speed has been increased, and the consumption of coal diminished, while the weight, vibration, and strain on the ship and machinery are considerably reduced. In addition to this, all these advantages are secured at a considerably less ultimate cost than by the use of steel, taking it upon the average life of a vessel; for although the first cost of a manganese bronze propeller, or a propeller with manganese bronze blades, is double that of steel, it is indestructible, whereas at the end of about every three years the steel blades become so pitted and corroded that their renewal will be indispensable, which brings up the total cost of the steel blades on an average to two or three times that of manganese bronze. That the manganese bronze propellers are incorrodible, and in every other respect efficient, has now been proved by experience, as some have been at work approaching three years and are as perfect in every respect as when first applied. Some time after introduction of the No. 3 quality for propellers, the No. 2 was used for some propeller blades, as fears were entertained as to the No. 3 setting up galvanic action and corroding the stern frames. Most of these propellers stood well, but some of the blades failed, and it was found on examination that the castings were unsound, owing to the metal having become deteriorated by melting in a reverberatory furnace. In consequence, it has now been determined to adhere solely to the No. 3, as this quality has always given the greatest satisfaction, both as to its facility in casting and efficiency under trial; and further experience proves the supposed galvanic action to be only a myth, or if there should be a tendency to it, it is effectually prevented by lining the inside of the stern frame with zinc strips. A proof of its soundness and tenacity was shown in an accident which occurred to one of the blades of the Garth Castle, at its launch from the yard of Messrs. John Elder & Co., in 1880, when one of the blades came in contact with the jetty, and was bent round without even a crack to nearly a right angle, and was afterward hammered back cold to its original form without detriment. The photograph exhibited shows the blade from two points of view bent and the other view as hammered back; another photograph shows one of the blades of the North German Lloyd's steamship Mosel (kindly lent by Messrs. John Elder & Co.) recovered from the ship after she was wrecked, and in which the metal was subjected to a still more severe punishment without breaking than even in the case of the Garth Castle

The other qualities, Nos. 4 and 5, of the manganese bronze have no particular claims to strength, but are most effective for the purpose of bearings, slide valves, slide blocks, piston rings, etc., and in all situations where friction occurs, and much more durable than ordinary gun metal. Before concluding, I may add a few words on the art of brass founding generally, and I cannot help saying that, as at present practiced, it is very far behind what might be expected in those days of progress. In the manufacture of iron and steel an amount of scientific knowledge has been brought to bear which elevates these industries into scientific processes, but I can discover nothing of the kind in bronze and brass founding—everything is there done by the rule of thumb, and that in a most clumsy manner. The idea of combining the various metals to form the alloys required in atomic proportions does not seem to have been ever entertained, and even the books written for the practical guidance of brassfounders ignore this important principle altogether. I must not be understood as applying this remark to Dr. Percy or Mr. Mallet, and other scientific metallurgists, who have drawn attention to the subject, and made valuable suggestions respecting it in their well-known works, but I allude to that class of books generally termed hand books, and the like, which contain instruction of the most clumsy and unscientific character, for making different alloys—thus for gun metal the proportions given are 1 lb. of copper to 2 oz. of tin, or if required to be harder 2¼ oz. or 2½ oz., and so on; then as regards brass, it may be 70 lb. of copper and 30 lb. of zinc, or 60 lb. of copper and 30 lb. of zinc, or 60 lb. of copper and 40 lb. of zinc, for yellow metals. Now, not one of these alloys or others described are in atomic proportions, and that is the reason why unsatisfactory results are constantly occurring in ordinary brass founding; not only are the copper alloys thus produced weak, soft, spongy, and porous, but it is a constant occurrence that the constituents vary in different parts of the casting. This is the case principally in the gun metal and bronze alloys. The surplus tin above that forming a definite alloy in atomic proportions seems to be held in mechanical suspension, which separates by liquation, and collects at the top of the casting as it cools and solidifies, causing the well-known tin spots, sponginess, etc. The only remedy the ordinary brassfounder has for this, is to use as large a proportion of scrap metal as he can get—he does not know why—he only knows that he gets better castings by using it, but the true reason is that the scrap metal has adjusted its con-

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stituents in atomic proportions during the several remeltings it has undergone, any surplus tin or zinc being got rid of by liquation and oxidation; but if in the original manufacture of the alloy the metals are combined in atomic proportions nothing of this kind happens, the castings are sound and the alloys homogeneous. In the manufacture of manganese bronze this principle is always kept in view, and all the different qualities produced have the metals they are composed of combined in atomic proportions.

Whether by this a really chemical combination is effected it is difficult to say; but this much I can vouch for, that the alloys thus produced are finer in texture, more homogeneous, stronger, and of a much more stable character, than when not so combined; thus in the No. 3 quality the addition of ¼ per cent. of tin, instead of making it harder and stronger, as it ought to be, according to the ordinary accepted ideas, actually makes it softer, weaker, and the grain coarser, and the same thing occurs if the additional tin is increased ½ or 1 per cent. until the tin arrives at another definite atomic proportion, when an alloy of a different character appears, but it then again becomes close-grained, sound, homogeneous, and stable. As a further proof of the soundness of this theory, the No. 3 quality may be passed through an ordinary reverberatory furnace, and although, in being thus treated it is exposed for a considerable time to the action of an oxidizing flame, no appreciable diminution of the tin in its composition has been detected. Then, again, both the No. 1 and the No. 2 may be remelted several times in the crucible, if it is done with care, without any alteration of their components. It is well known how difficult it is to melt brass and yellow metal, even in a crucible, when every precaution is taken, without some of the zinc escaping in fumes; this, also, to a certain extent, occurs in melting the No. 1 and No. 2 manganese bronze, but the zinc apparently carries with it its atomic complement of copper, so that the proportions of what remains are not disturbed. I am led to this belief, not only by examining the metals after remelting, but by the color of the condensed fumes, which, instead of being white as they are when produced from zinc alone, have a beautiful pink color, which I can only attribute to the presence of copper. Another and perhaps still more palpable proof of the value of combining the metals in their atomic proportions is that, when this is done, the specific gravity of these alloys is perceptibly increased over those not so combined, even though in the latter case the heavier metal be in excess. I was much struck by this fact in taking the specific gravity of some No. 1 manganese bronze, which contains a large amount of zinc, and which, judging by its constituents, ought to be a comparatively light metal, but the trial proved that it was about equal to that of ordinary gun metal, composed of copper and tin, and very considerably above the mean weight of the metals composing it, indicating to my mind that these metals must have combined in such a manner as each to fit into and fill up the infinitesimal spaces between the molecules of the other, and if not actually forming what chemists would admit to be a perfect chemical combination, certainly more nearly approaching it than when the metals are mixed together in the haphazard manner usually prevailing. I have no doubt that these combinations and the stable quality of the manganese bronze alloys is also due very materially to the action of the metallic manganese on the copper, in freeing it from the oxides it contains, and thus bringing the metals added to it into actual contact, and enabling them to combine in a more perfect manner than has been accomplished hitherto. I have only now to refer to the list of tests appended, which it would be tedious to recite, but they can be referred to, and the results will be found attached to the samples, as also a description of the other articles exhibited.

TESTS OF MANGANESE BRONZE BY TENSILE STRAIN.

Description.	Where Tested.	Reference Number.	Elastic Limit, Tons per Square Inch.	Breaking Strain, Tons per Sq. Inch.	Ultimate Elongation, per cent.	Remarks.
No. 1 rods rolled hot.	R. G. F.	6,536	11·00	29·00	44·6	Mild, annealed for riveting cold.
	U. L C.	5,060	13·17	29·29	33·4	Annealed.
	Ditto.	4,995	23·54	31·60	26·5	As delivered from the rolls.
	Ditto.	4,996	24·32	31·43	23·3	
	R. G. F.	6,547	34·40	39·60	11·6	Ditto, and finished cold.
No. 1 Plates, rolled hot.	R. G. F.	7,365	14·06	28·46	23·2	Pulled across Fiber. Annealed.
	Ditto.	7,369	14·06	30·13	47·8	Pulled with Fiber. Annealed.
	Ditto.	7,373	14·80	30·78	34·1	Pulled across Fiber. Annealed.
	Ditto.	7,374	16·70	30·10	28·8	Pulled with Fiber. Annealed.
No. 2 cast under pressure.	M. B. & B. Co.	1	18·00	35·00	22·0	Cast in an iron cylinder and pressed while liquid.
	Ditto.	2	16·23	31·90	12·4	

No. 1 cut from side of ingot, and No. 2 from center.

TESTS OF MANGANESE BRONZE BY TORSION.

Description.	Where Tested.	Reference Number.	Diameter Ins.	Twisting Moments in Inch Pounds: Elastic Limit	Twisting Moments in Inch Pounds: Breaking Strain	Amount of Twist in length of one diameter. No. of Turns.	Remarks.
No. 2 cast under pressure.	U. L. C.	5,023	0·622	1,170	3,360	0·183	Uniform twist.
	Ditto.	5,024	0·634	1,200	3,373	0·166	Ditto.
No. 1. rolled.	Ditto.	5,064	0·621	1,110	3,280	0·175	Annealed.
Rod........	Ditto.	5,065	0·621	1,060	3,242	0·165	Rolled hot, and tested as it came from rolls

No. 5,064 was removed from machine unbroken.
No, 5,065 was broken, showing a clean shear.

TEST OF A BAR OF MANGANESE BRONZE, NO. 3, BY TRANSVERSE STRAIN.

(1 inch square, cast in sand, placed on supports 12 inches apart, steady pressure applied in middle of bar.)

Strain in Pounds.	Deflection, Strain on, Inches.	Per Set, Strain off, Inches.	Strain in Pounds.	Deflection, Strain on, Inches.	Per Set, Strain off, Inches.
896	0·025	—	2,688	0·21	0·12
1,120	0·03	—	3,136	0·44	0·34
1,344	0·04	—	3,584	0·86	0·73
1,568	0·045	—	4,032	1·62	1·44
1,792	0·05	0·005 } E limit	4,144	1·97	—
1,904	0·055	0·01 } E limit	4,256	Gave way without breaking, and bent to a right angle.	

EXPERIMENTS ON THE TRANSVERSE STRENGTH AND TOUGHNESS OF BARS OF MANGANESE BRONZE AS COMPARED WITH WROUGHT IRON AND GUN METAL, MADE BY DROPPING A WEIGHT ON THE MIDDLE OF THE BAR RESTING ON SUPPORTS AT EACH END.

Weight of monkey, 50 lb.; height of fall, 5 feet; distance between supports, 1 foot; dimensions of bar, 1 inch square, 14½ inches long.

Permanent Deflection in inches, in the length of 12 inches.

Number of Blows.	Wrought Iron. Staffordshire Rolled. No. 1	Wrought Iron. Staffordshire Rolled. No. 2	Gun Metal. Cast in Sand. No. 1	Gun Metal. Cast in Sand. No. 2	Gun Metal. Cast in Sand. No. 3	Gun Metal. Cast in Sand. No. 4	Gun Metal. Cast in Sand. No. 5	Gun Metal. Cast in Sand. No. 6	Manganese Bronze. No. 3 Cast in Sand. No. 3	Manganese Bronze. No. 3 Cast in Sand. No. 4	Manganese Bronze. No. 1 Forged. No. 5	Manganese Bronze. No. 1 Forged. No. 6
1	0·57	0·58	0·82	0·86	0·90	0·72	0·73	0·46	0·66	0·60	0·59	0·60
2	1·10	1·15	1·50	1·58	1·63	1·32	1·42	and broke	1·20	1·15	1·06	1·08
3	1·62	1·71	1·70	2·22	2·35	1·92	1·52	—	1·70	1·60	1·44	1·50
4	2·13	2·23	and broke	and broke	2·86	1·94	and broke	—	2·23	2·07	1·80	1·89
5	2·65	2·77	—	—	and broke	and broke	—	—	2·67	2·52	2·12	2·26
6	3·19	3·37	—	—	—	—	—	—	3·11	2·97	2·45	2·65
7	3·77	3·99	—	—	—	—	—	—	3·58	3·39	2·77	2·90
8	4·29	4·63	—	—	—	—	—	—	4·02	4·04	3·05	3·28
9	not broken	not broken	—	—	—	—	—	—	not broken	and broke half through	3·33	not broken
10			—	—	—	—	—	—			not broken	
11			—	—	—	—	—	—				
12			—	—	—	—	—	—				
13			—	—	—	—	—	—				

Gun Metal.—The specimens Nos. 1, 2, and 3 were sent from the locomotive works of one of the railways terminating in London, and tested in the presence of an officer of the department, and fairly represent the qualities of gun metal ordinarily found in such works, and supplied by brass-founders. Nos. 4 and 5 were cast specially and composed of best selected copper, 16 parts, English tin, 2 parts; No. 6 of copper 16 parts, and tin 2½ parts by weight.

SOLAR SURROUNDINGS.

By RICHARD A. PROCTOR.

MY friend Dr. William Huggins, the eminent physicist and astronomer, entertains the confident belief that he has succeeded in photographing the solar corona without the aid of a total solar eclipse. I am myself not quite convinced that what he has photographed is really the corona, though I would fain hope so. And yet the evidence seems strong enough. His method is simple and probably well known not only to men of science in America but to most of that large population there which, without being scientific, takes interest in scientific matters. I therefore only sketch it, and that lightly.

He takes advantage of the fact that a large proportion of the light of the corona belongs to the violet end of the spectrum, and uses absorptive media which allow this sort of light and this only to pass freely through. Then when the photographing telescope is turned toward the sun and the coronal region, the violet light of the corona, which is relatively strong, only has to contend against the violet light from the sky around the sun's place, and has at least a better chance of making its presence known—in other words, a better chance of recording a recognizable picture of the coronal steamers on the photographic plate, on which necessarily the light from the sky is combined with the light from the corona. It seems clear that if the image is taken first near the center of the telescopic field and then near a side, any optical effects due to the structure of the telescope itself must be detected and eliminated. Streamers simulating a coronal appearance could not possibly be alike in both positions. So any other purely instrumental peculiarities can, it would seem, be corrected. As for any coronal streamers caused by our own atmosphere, they must be corrected if we take pictures on different days or at different hours. If, under such varying conditions, we find that still certain streamers remain which can be recognized as the same in all the different pictures, it certainly seems as though there must be true coronal streamers. This is what Dr. Huggins claims to have done, and it is what his pictures really seem to show that he has done. So that scarcely know how to justify the doubts which yet I cannot help entertaining. These streamers are so faint and shadowy (though that of course they could not but be), it is so easy "to make believe a good deal," as Dick Swiveller puts it, in looking at appearances so delicate, especially when (as in my own case) we wish very much to believe that a great scientific triumph has been achieved, that an excess of caution comes over me, and despite the agreement of men so competent to judge as Dr. Huggins, Professor Stokes, and Captain Abney, my mind in this matter "asks for more."

Perhaps one would not be so ready to entertain still a little doubt were it not that the matter is one which can so very readily be tested. Dr. Huggins' method is one which can be applied under especially favorable conditions in the clear skies of America. There are also in America magnificent instruments for testing the method. I should be glad to learn that the mantle of my late most esteemed friend Dr. Henry Draper had fallen on a successor as zealous in the cause of science as he was; nay, even that the instruments he employed so successfully had been directed again to the class of work for which he made them, but with a slight change of subject. Solar photography is making great progress in England; but we have not the favorable conditions which exist in America. It has even been said by a French author, who under the *nom de plume* of Max O'Rell (impossible name!) has recently discussed John Bull and John's island, that we photograph the sun in England whenever we get the chance, lest we should forget him. Without being quite so bad as that, our atmosphere is certainly not the best suited in the world for the very delicate and difficult problem attacked by Dr. Huggins. (Professor Daniel Draper has indeed shown that out of 4,449 possible hours of sunshine, New York had 2,936 actual sunshine hours in 1878 and 3,101 in 1879, say in round numbers 3,000 hours; whereas at Greenwich, with only two hours less of possible sunshine, there were but 1,245 hours of actual sunshine in 1878 and 977 in 1879, an average of 1,111 hours only.)

It may perhaps be thought by some who have noted the supposed discovery made by Dr. Hastings and Professor Holden during the eclipse of May last that astronomy ought to assure itself that the corona exists, before attempting to photograph it. If the corona has really been proved to be merely a phenomenon of diffraction, as has been so confidently and also so strangely asserted, the diffraction, taking place at the moon's edge, then of course when the moon is not there to produce that diffraction corona it is idle to attempt to photograph what—in that case—has no existence even as an optical phenomenon.

It has been with not a little suprise that the news of this noteworthy discovery has been received by astronomers. An observation which if it prove anything proves only what every one knew must be the case—viz., that light passing close by the moon in total eclipse undergoes diffraction—is astoundingly accepted as explaining the solar corona with its complex structure, its long streams, its faint extension along the zodiac even beyond the streamers five millions of miles in length seen by Professor Cleveland Abbe in 1878 and by General Myer in 1869. It is perfectly well known that diffraction could account only for a fine coronal ring of light, not even for the inner bright corona, still less for the structured corona near the sun, and least of all for the long streamers. Yet the mere circumstance that Dr. Hastings saw what it was practically certain beforehand he would see if he looked for it—viz., evidence of diffraction—is at once taken as full and complete evidence about matters with which it is not in the remotest degree connected.

The theory that the corona is not a solar appendage was not altogether an unreasonable though it was a demonstrably wrong theory, fifteen years ago. It was clear even then to those who considered the matter attentively that none of the non-solar theories which had up to that time been advanced (including the diffraction theory discussed half a century ago by Baden Powell) were sound. But even the scientific world has been slow to accept the results of mere reasoning, so that in 1869, when the celebrated American eclipse occurred, astronomers were beginning to hope that photography would dispose of the solar corona as it had already disposed of the solar prominences. There had been some who denied that the colored prominences could belong to the sun, pointing to difficulties akin to those which Mr. Larkin urges, I see, in *The Kansas City Review*, against the doctrine that the corona is solar. Then photography, showing in successive views of the totality in 1860 how the moon passes athwart the colored flames, disposed definitely of the lunar and atmospheric theories of the garnets round a brooch of jet, as the colored flames had been poetically called. Photography in 1870 did the like for the corona. An American photographer at Xerez in Spain and an English photographer at Syracuse in Sicily showed in their views the same radiations, rifts, gaps, and general structure in the corona—which could never have happened if the atmospheric glare, the lunar explanation, or any other but the solar theory of the corona had been sound. In 1871, in India, six photographs taken at Baikul, close to the seashore, and six taken at Ootacamund, some 10,000 feet above the sea level, showed the same coronal features, all twelve of them. This was not so much a demonstration as *the first easy proof* of the solar nature of the corona—for even a schoolboy (not Macaulay's school boy, who knew everything, but a real one) could see that unless the corona were far beyond our atmosphere and far also beyond the moon, it could not possibly show the same features as seen not only from stations hundreds of miles apart, but also at the beginning of totality, when the moon's eastern edge is just hiding the corresponding edge of the sun, and throughout totality to the last moment, when the western edges of the globes are in apparent contact. Consider the mighty shadow of the moon sweeping along past and over the observer, remembering what the shadow in our air really is, a great cylindrical (really a frustum of a cone but very nearly cylindrical) region of darkness from fifty to a hundred miles or so in diameter; and see the impossibility that when the observer is on the extreme eastern side and on the extreme western side of that shadowed region he should see the same appearance in the air, or anywhere but in a region many millions of miles away, as around the sun. Add the impossibility that at stations two or three hundred miles apart the same appearances are seen, and not only seen but pictured by the unerring pencil of photography.

Yet it must be admitted that a certain interpretation of the corona as a solar appendage is so full of difficulties that one cannot wonder at its having proved a stumbling block to many. I mean the view that the corona is a solar atmosphere. The existence of gaseous matter in the corona does not any more prove, as some seem to imagine, that the corona is an atmospheric envelope than the existence of gaseous matter in comets, demonstrated over and over again, proves that comets form an atmospheric envelope of the sun. The whole aspect of the corona seems to me to show unmistakably that the several parts of that solar appendage are as free from atmospheric association with the sun as are meteor streams and the heads and tails of comets. I doubt even for my own part whether what we call the visible surface of the sun indicates the extension of a continuous solar atmosphere to that distance from the sun's center. And that the sierra (which some still call the "chromosphere," a word as correct and pleasing as "phograph" to a classical ear) is not really an atmospheric envelope, in the correct sense of the expression, seems clear when we consider its depth and the inconceivable pressures which would exist at the base of such an atmosphere under the solar gravity, exceeding more than twenty-seven fold that at the earth's surface.

If Dr. Huggins' photographs of the corona are real, the doubts even of those not capable of understanding the photographic evidence already obtained will be dispelled; and to question the solar nature of the corona will be held as obviously absurd as it would now be in the presence of the daily study of the solar prominences to maintain that *they* are only phenomena of diffraction.—*New York Tribune.*

Kew, England, Dec. 5, 1883.

OLD ENGLISH FURNITURE.

"Come, musicians, play.
A hall! a hall! give room, and foot it, girls.
More light, ye knaves, and turn the tables up."

SUCH is the exclamation of Capulet in "Romeo and Juliet" as he enters the hall with his guests, and the same need of space for dancing and other festivities is still felt, especially at this season of the year, when dining tables, useful enough, of course, in their way, have to be turned out or folded up and run together with the "leaves" taken away to "give room." In earlier times—that is to say, in the days of Chaucer—the primitive trestle and boards gave place to what he calls the "Table Dormant," or permanent table, used at first only by the distinguished and fashionable, or at the high seat in the hall of my "Lord and Ladie." Gradually these tables became richly elaborated with grandly-proportioned legs and carved friezes, very heavy and solid, though narrow and comparatively small. The tops, however, were made with long, extending leaves, supported on sliding bearers, which ran into the table proper, and thus the festive board could easily be made three-fourths as long again as its original form, and still retain the stability of the whole piece. A "drawing table" of this kind we illustrate to-day in the center of the accompanying sheet of old English furniture reproduced from Shaw. It is a fine and typical example, with singularly good detail. The upper "leaf" is lifted, while the two under ones are drawn out as already indicated, and then, by its own weight, the center top falls into the space just fitted to receive it, when the whole length of table is of one level, and literally "as firm as a rock." This specimen, from Leeds Castle, Kent, is characteristic of the Elizabethan style, with finely developed ornaments on a sort of Grecian model intermixed with foliage. The Folding Table from Hill Hall, Essex, is of earlier date, and like the Chair illustrated from Mitchel Dean, Gloucestershire, may be taken as fine examples of "Romayne work"—that is to say, they are carved with medallions inclosing heads and masks after the fashion set by Raphael and other celebrated painters, who adopted forms suggested by the antique in their frescoes and details of ornamentation. The plan of the table here drawn is given to scale with figured dimensions, and the chair really explains itself. Like the table, it is in oak, and besides having the beautiful "Romayne" panels within the back, as seen in our view, has fine napkin paneling on the outer panels carried out in the usual Tudor manner. The 15th century Buffet, from an illuminated MS. in the King's Library, at Paris, shows an elegant and dignified piece of furniture, rich in Flamboyant tracery and moulded work. According to Willemin, the old etiquette of France, certainly that of Burgundy, prescribed five shelves or steps to buffets or "dressoirs," for use during meals for Queens, four for duchesses and princesses, three for their children, and for countesses and *grandes dames*, with two for other noble ladies, and one "degrés" for "knights-bannerets and unennobled persons of gentle descent." A five stage sideboard of this sort is given in a volume published at Dilingen in 1587, descriptive of the ceremonies at Prague when the Grand Duke Ferdinand of Austria invested the Emperor and the Grand Dukes Carl and Ernst with the order of the Golden Fleece. Here elaborate gold plate, quaintly fashioned and massively made, was duly displayed as indicative of royal wealth and splendor, but the "dressoir" itself was comparatively mean and unpretending. The napkin press from Goodrich Court, Herefordshire, of the time of Elizabeth, which figures in the other corner of our plate, is thus described by its owner, Sir Samuel Meyrick: "It is of oak, with the handle of the drawer, the exterior ornaments on the square uprights, and the urns above them, of ebony, and it occupies a place in the room known as 'Sir Gethley's Chamber,' but was evidently intended for use in the dining hall or refectory." The unique Cradle of Henry V., originally from Courtfield, Monmouth, is probably the earliest specimen extant, and the beautiful carving on the angle pieces of the supporting uprights corroborates the date assigned by tradition to this royal "esperver." Bonner in his "Itinerary," the *London Magazine* for 1774, and Bingley in his "Tour through North Wales" gave poor engravings of this interesting piece of antiquity, but these only served to record its existence and gave no proper idea of its character. Henry was born at Monmouth in 1388, and was sent to Courtfield in that county, about seven miles off, to be nursed for the benefit of his health, under the superintendence of Lady Montacute, who provided this cradle for his use. It was preserved at Courtfield for many years, until the steward of the property, greedy of gain, contrived its removal and sale. It then got into the hands of the Rev. Mr. Ball, rector of Newland, Gloucestershire, but records do not say how he obtained the cradle, whose next owner was Mr. Whitehead, of Hambrook, who sold it to Mr. Braikenridge. Its dimensions are 3 ft. 2 in. long, 1 ft. 8 in. wide at the head, 1 ft. 5¾ in. at the foot, and 1 ft. 5 in. deep. The uprights, including the birds, are 2 ft. 10 in. in height. The last piece of furniture to be described here is the Wassail Table and a pair of side Candelabra, which occupy the central position on our sheet of illustrations. There is a tradition which tells of these curiosities having been captured with the baggage of Charles the First after the battle of Naseby; but the character of the furniture itself hardly agrees with the story, as, for instance, the twisted column in articles of furniture is not usually found till the following reign, while the probability of the flying monarch incumbering the march of an army with Wassail tables and candelabra is not sufficiently likely to countenance the otherwise ingenious tale. They are said to have belonged to the Cockayne family ever since the time of Charles the Second. The Wassail bowl, like the cups, is made of dark wood, the enrichments are in ivory. In England "treen vessels" preceded pewter, as pewter did silver.

"Beech made their chests, their beds, and their stools,
Beech made the board, the platters, and the bowls."

Maple cups were used at the coronation of Edward III., and also George III., and "mazers" of "dudgeon" wood, whatever that may be, are also mentioned. The Scottish ballad of Gil Morrice places the silver cup and the mazer in use together.

"Then up and spake the bauld baron,
An angry man was hee;
He's ta'en the table wi' his foot
Sae has he wi' his knee;
Till siller cup and mazer dish,
In flinders he gard flee."

—*The Building News.*

ANCIENT TILES.

TILES were used in great quantity in ancient Mesopotamia among that wonderful people that has utterly passed away, leaving mural remains indicating that it was the most densely populated region of antiquity.

In that country the common mode of keeping records of national and historical events was by stamping inscriptions upon tiles of clay, which were baked after the impression was made. Mr. Layard, in the course of his excavations at Nineveh, found a large number of these records; some of these were written with such minute characters that a microscope was required to decipher them. He believed that they were read by a magnifying lens, one of which, made of rock crystal, he found among the ruins of the palace of Nimrod.

These tiles are stored away in such order that they were evidently records, but a common description of tile furnished the material for many of their structures, sometimes in conjunction or alternation with brick, from which it differed more in form and proportions than in any essential respect.

The tiles of Assyria and China lead the way, as far as the history of this art is concerned, for the Egyptian system was not favorable to the existence of tiles, even in rainless Upper Egypt. While the bricks of Babylon were some burnt and some adobes, the bricks of Egypt were universally adobes, or merely sun dried, and this does not suit a thin tile, however well it may answer for a thick brick. The references to tiles in Holy Writ are not unfrequent. We read of tiles in Ezekiel and in the Gospel of Luke, when the sick men was let down through the tiles. Tiles were also common in Rome at that day.

The art of glazing tiles came from China, and before the introduction westward of this Chinese art neither bricks, tiles, nor earthenware was glazed, but in cases where it was necessary to render their earthenware vessels water-proof they were daubed with pitch, wax, tallow, or other resistant.

The vitreous glazes passed from China to India and spread thence after the conquest of the latter country by Mahmond of Ghuzna, the bogy of the warrior episode in Moore's "Paradise and the Peri." His conquest occurred A. D. 1000, about the time that Gerbert of Auvergne, the schoolmaster of Rheims, was introducing the civilization of the Spanish Saracens into France and Italy.

The passion for glazed tiles spread from India and Ispahan to Spain, from the thirteenth to the sixteenth century.

The palace of the Alhambra at Granada, the residence of the Moorish kings, was built in 1280, and many of the rooms are ornamented with glazed tiles.

The tomb of Sultan Mohammed Khoda-Bendeh, at Sultanieh in Persia, was also built in the thirteenth century, and is ornamented on the cupola and minarets with a green glazed tile, and on the architrave with a dark blue one.

The painted mosque of Gour, in India, now in ruins, was built in 1475, and derives its name from the profusion of glazed tiles which adorned it.

In Ispahan, the domes and mosques are covered with green and blue tiles; and the caravanserai at Mayar, near Ispahan, built in 1580 by the mother of Shah Abbas, is inlaid with green tiles.

The art of glazing tiles passed from Spain to Italy, which

soon became celebrated for the taste and execution of its works in that line. Raffaello himself made designs for the paintings in *terra invitriata*.

The art spread to Holland and long abode there. Delft was its headquarters; and the Dutch tiles, which some of us can recollect as lining the capacious fire-places of old mansions, have been studied by many thousands besides the excellent Doddridge, who there learned Scripture history.

Rome was originally roofed with shingles; tiles of baked clay were introduced about the time of the war with Pyrrhus (290 B. C.).

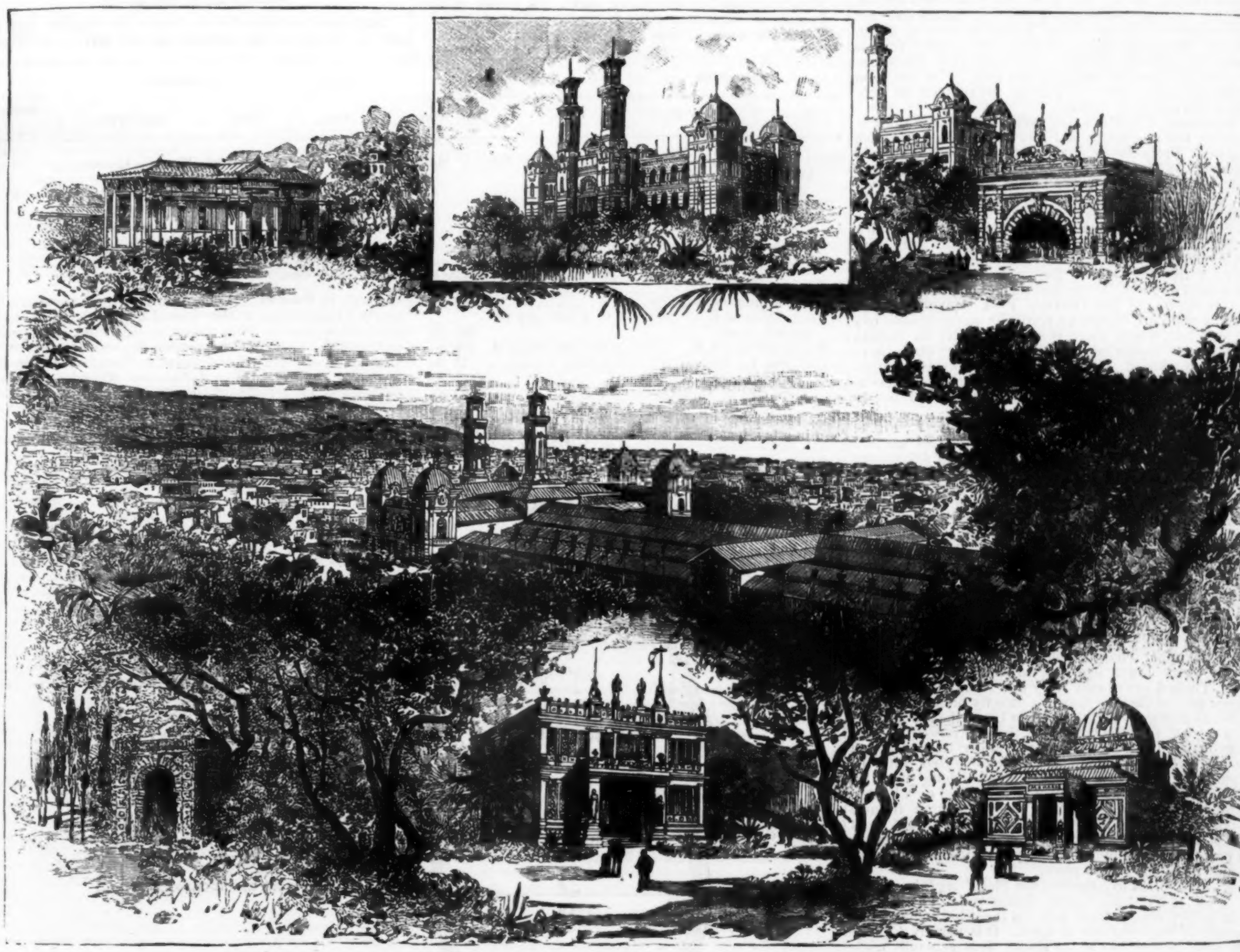
Tiles of marble were used in Greece about the time of Pausanias, 620 B. C. The temples of Jupiter at Olympias and Athenæ at Athens (the Parthenon) were thus covered.

Tiles of bronze, gilt, were also used in some cases. The lower edges of the joint tiles were protected and ornamented by *frontons*. The edges of the flat tiles were turned up and covered by semi-cylindrical joint tiles, termed *imbrices*.

The Greek and Roman tiles were made of marble, and have been imitated in clay.

Tiles were used in Rome and Greece as follows: Flat tiles with raised edges extended from rafter to rafter, the upper end having a rib that entered a groove formed on the under side of the tile placed above it. After these were laid, the joints above the rafters were covered with other tiles, each formed like the half of the frustum of a hollow cone, so that they were able to lap upon each other, their edges lying snugly to flat tiles on the roof. The end of these ridges was terminated by an ornament.

Tiles both flat and curved were in great demand in Roman architecture. Roofs were covered with the flat and curved tiles alternating. Tiles two feet square with a foot at each angle were used to line the thermæ, so that an air space between them and the wall should prevent the absorption of water by the latter.—*Glassware Reporter*.



THE INTERNATIONAL EXHIBITION BUILDINGS AT NICE, FRANCE.

TO DETECT FLOUR MADE FROM SPROUTED WHEAT.

It not infrequently happens, says Dr. Heppe, that a baker or flour dealer will bring a sample of flour to the chemist for examination in the belief that it has been adulterated, as it does not bake well, yet in which no foreign substance can be detected.

Such flour is generally made from "grown" or sprouted wheat. The presence of such wheat can easily be detected by its acid reaction. It is true that an acid reaction might be due to the flour being damp for a long time, but then it has a musty odor and taste, and is of doubtful quality. If this smell and taste are absent and yet the flour has an acid reaction, it must be due to the presence of grown wheat.

To prove the correctness of these statements it is only necessary to crush a few grains of good, unsprouted wheat in a mortar and test its reaction, which will be found to be neutral. Then moisten a few grains of the same wheat and keep them damp until a little white spot appears, when they may be crushed and will give a decidedly acid reaction.

The best method of applying the test consists in stirring the flour up with water, filtering, and testing with corallin solution, rendered red with a trace of alkali; if the flour is acid, it turns yellow. Methyl orange can be used, litmus is less delicate.—*N. Erfindung*.

REDUCTION OF METALLIC SOLUTIONS BY MEANS OF GASES, ETC.*

By Dr. G. GORE, F.R.S.

The following experiments were made chiefly for the purpose of ascertaining the effect of various gases and liquids in reducing metals from their solutions.

Experiment 1. A mixture of dry and pure carbonic oxide and carbonic anhydride gases, passed in a stream slowly through various liquids, had the following effects: A solution of bichloride of palladium was rapidly decolorized, and all its metal precipitated as a black powder. One of tetrachloride of platinum was slowly decomposed, and yielded a small amount of yellow precipitate in two or three days. With one of chloride of iridium and potassium, the whole of the iridium was precipitated after a long time. Solutions of argentic nitrate, mercuric chloride, plumbic nitrate, ferric chloride, manganous chloride, permanganate of potassium, chromic acid, and a green solution of vanadium showed no signs of reduction. A solution of green vitriol with which an excess of pure sodic hydrate had been mixed did not become oxidized.

2. The same mixture of gases was passed through a lead vessel containing milk of lime. It imparted to the surface of the vessel a film of red oxide of lead, probably by reduction of carbonate of lead by the carbonic oxide.

3. By passing carbonic oxide during two days through a solution of potassic cyanide with a rod of bright magnesium half immersed in it, the liquid became brown, and the metal was coated with a blackish film in the liquid. Magnesium alone in a similar solution did not turn the liquid brown in three days.

4. A dilute solution of bichloride of palladium exposed to a mixture of hydrogen and carbonic anhydride (or to pure hydrogen alone) had the whole of its palladium gradually precipitated in the metallic state in a period of twenty-four hours.

5. An atmosphere of coal-gas was maintained in contact with the following dilute liquids, each of which had a vertical platinum wire partly immersed in it. The liquids were in open bottles in a dark place. Dilute solution of palladic chloride: Rapid reduction to the state of metal as a film upon the surface of the liquid in four hours; the solution became colorless in a few days; some of the metal was also precipitated as a black powder, and some as an adhering bulky lump on the end of the wire. With dilute terchloride of gold, in the course of a few days, beautiful films of metal, bright, and of exceeding thinness, were produced upon the surface of the solution. Much gold was also deposited upon the bottom end of the wire. The films formed successively, and sank. The liquid was not wholly decomposed in three weeks. Solid crystals of auric-chloride were gradually reduced to metal. Solution of platinic chloride was only slightly decomposed in ten weeks. With a solution of argentic nitrate: Signs of decomposition occurred in a few hours. In fourteen days a deposit of metal had formed upon the sides of the glass bottle; but the whole of the silver was not deposited in seven weeks. With cupric sulphate, no reduction, and but little action upon a strip of copper (instead of platinum) took place in ten weeks. With a platinum wire in a dilute solution of ferric sulphate, no visible effect occurred in eighteen days.

6. The gaseous products (containing acetylene) of a blown down and smoky flame of a Bunsen burner were collected over water and passed through various liquids. They rapidly decomposed a solution of palladic chloride, and less quickly one of terchloride of gold; a solution of platinic chloride was slightly affected, and one of chloride of iridium and potassium remained unaltered.

7. A solution of palladic chloride in contact with amylene showed signs of decomposition even in a few minutes, and was abundantly decomposed in two days; it was also reduced to metal by American petroleum, benzine, and Persian naphtha less speedily; slowly by toluol, xylol, "petroleum ether," and mesitylene; with the ether, a bright metallic layer was formed between the two liquids. It was reduced very slowly by Rangoon lamp-oil, and by "sherwoodole," and not at all by ozokerite, solid paraffin, or naphthalene.

8. An aqueous solution of auric chloride, especially a strong one, was rapidly decomposed by carbolic acid, with liberation of the metal; also, but more slowly, by mineral naptha, Persian rock-oil, benzole, C_2Cl_2, and Rangoon machinery oil, with similar effects; slowly by "petroleum ether," and very slowly by toluol, xylol, and mesitylene; paraffin, anthracene, naphthalene, C_2Cl_4, Rangoon petroleum butter, C_2Cl_6, benzoic acid, soft elaterite, hard elaterite, CCl_4. Sherwoodole, chrysene, or ozokerite had but little or no decomposing effect. The solution of chloride of gold was less rapidly decomposed than one of palladic chloride, especially by mineral naphtha and benzole. Amylene produced a most beautiful film of gold upon the surface of the auric solution.

9. Platinum was separated from a solution of platinic chloride by benzole, American rock-oil, Persian naphtha, and other similar liquids.

10. An aqueous solution of chloride of iridium and potassium was decolorized in two days by contact with benzole. With amylene no effect was visible in that time.

11. Amylene, in contact with an aqueous solution of mercuric chloride during one week, slowly produced a white precipitate. By agitating amylene with a solution of permanganate of potassium, the latter was instantly decolorized; the residue was entirely soluble in hydrochloric acid, but with one of cupric chloride in aqueous ammonia, or of ferric chloride, chromic acid, chromate, or acid chromate of potassium, no visible effect occurred.

12. Benzole, agitated with a solution of potassic permanganate, rapidly decolorized it, but had no effect upon one of perchloride of iron. Benzole darkened the color of solutions of palladium, gold, and platinum.

13. With a solution of telluric chloride, or one of terchloride of antimony, amylene, benzole, and Persian naphtha produced only a slight effect in fourteen days. With Persian naphtha and a solution of chloride of bismuth, a slight change occurred in eleven days.

The films of gold and palladium formed upon the surface of a liquid by contact of a gas, or between two liquids at their dividing line by a non-miscible solution, might prove of service in some physical experiments.

It is worthy of consideration whether the reduction of metals to the native state in the interior of the earth may not

* Read before the Birmingham Philosophical Society, December 13, 1883.

in some cases have been effected by contact of their solutions with liquid or gaseous hydrocardons derived from coal and other mineral substances of organic origin.

MANUFACTURE OF CHARCOAL IN KILNS.

CONICAL KILNS.

THE conical kilns are generally smaller than either of the other varieties before described. They are usually from 20 to 25 feet in height and from 25 to 30 feet in diameter, and are intended for 25 to 45 cords of wood. They are constructed in such a way as to require no bracing of any kind. They are often built into the side of a bank, a part of the earth of which is removed so as to make a charging-door near the top on a level with the groûnd; or they may be built on a plain, in which case there is no upper door but only a charging hole in the top, which is reached by a ladder in order to close it.

The usual dimensions of these kilns are:

	Diameter at base, feet.	Height, feet.	Capacity, cords.
American Fork Canyon, Utah .	26	20	25
Norton's Iron Works, Plattsburg, N. Y	30	20	35
Wassaic, N. Y	30	23	40
Readsboro', Vermont...........	28·6	28	45

There are three types of this kind of kiln, shown in Figs. 6, 7, and 8. 1. That at Readsboro', Fig. 7, in which the top of the cone is at a different angle from the bottom; there are two doors of the same size for charging. 2. That at Wassaic, Dutchess County, N. Y., Fig. 6, in which the cone has but one angle; there are two charging doors of slightly different size, and a hole in the top of the kiln to be used in firing. 3. That at Plattsburg, No. 8, in which the conical form is the same throughout; there are two charging doors, one below, and the other in the top of the kiln. This last form is on the whole the best of all, being the simplest in construction and easiest to manage.

At Readsboro', Vt., Fig. 7, the walls are 12 inches thick at the bottom, but at a height of 7 feet 4 inches they diminish to 8 inches. From this height upward all the bricks are laid in headers. At the height of 28 feet the kiln is capped by another cone, which is 5 feet 4 inches high, and of much flatter angle. The details of construction are different in different localities, but the principle of all the kilns is the same. At Wassaic, Fig. 6, the walls are made 30 inches thick at the bottom, diminishing gradually to 14 inches at the top, which is made flat for a cast iron vent hole. On one side a doorway, 7 feet high and 6 feet wide, is built out, into which a sheet iron door fits against flanges made for the purpose. On the line of the American Fork Canyon Railroad the bottom walls are carried up vertically on the outside to a height of 5 feet, where there is an offset. At the bottom the walls are 18 inches thick; at the offset they diminish to 1 foot in thickness. The interior is, however, conical throughout. The foundations are of the same thickness as the lower walls, and, as they are in earth, are 10 feet in depth.

At Norton's Iron Works, near Plattsburg, N. Y., Fig. 8, the wall is built with a batter 3 inches to the foot up to 5 feet. At this point, the height of the kiln being determined at 20 feet, a perpendicular is raised, and somewhere on this line a center is found from which an arc of a circle will meet the flange of the charging hole at the top, which is made of a cast-iron ring 4 feet in diameter and 8 inches deep, projecting 6 inches over the top. This makes the wall a little thinner at the top than the bottom. The flange of the ring is normal to the curve of the masonry, which is generally built of red brick (Fig. 8 shows the way this kiln is constructed). Sometimes the kilns are made of stone, which need only be strong enough to resist the low heat of the operation. Constructed in this way the kiln requires no braces of any kind. When the kiln is built against the side of a hill, the upper charging door is generally made of the same size as the lower one, but in Utah it is only 4 feet square. These doors usually have iron frames. Sometimes the upper part of the door-frame is directly under the top of the cone, as at Wassaic, Fig. 6, and in Utah; the lower one is then on a level with the bottom of the excavation made in the side of the hill. Sometimes the upper door is much lower, as at Readsboro', Fig. 6, and is connected with the woodyard by means of a bridge. At Plattsburg the kilns are built on a plain—the top opening is reached by a ladder. The discharge door is square, and has a cast-iron frame 6 feet high and 4 feet 6 inches wide. It is best to put in at the top of this door-frame a rod ¾ of an inch in diameter, to prevent the tearing of the wall by expansion. The door itself may be in one or two pieces.

It takes 33 M. brick to construct the Plattsburg kiln. About 40 M. brick to build the one at Readsboro'. The floor of the kiln is very nearly level, and on the sides comes up to the bottom of the lower tier of vents. It is usually 4 inches higher in the center than at the sides. It is generally made of clay 8 to 12 inches thick, and must be well beaten with mauls and very carefully tempered. The kiln has 3 rows of vent-holes, which usually commence on the level ground.

Each kiln is usually constructed to hold 35 cords of wood, solid measure. This is intended to yield 1,750 bushels, which is 50 bushels to the cord. Either soft or hard wood can be burned; the former is generally used in the manufacture of blooms, and is preferred by many workmen.

To charge the kiln, skids two inches in diameter are laid three feet apart, keeping the ends up to the outside. They must be placed in the radii of the circle, for if the smoke is at all confined it will cause an explosion. The wood used is cut 4 feet 8 inches long, and is of all sizes from four inches to two feet in diameter.

A fire place or chimney four feet square is made in the center of the kiln, and carefully preserved in the filling to the top. An air channel is made from it to the opening in the lower door. This is filled with shavings, brands, and light wood, thrown in loose, which when the kiln is lighted is fired with a long pole from the door.

The yield of the kilns at Norton's works is often as high as 60 bushels per cord for hard and 50 for soft wood. The average is about 50 bushels.

There are 13 kilns here, and 4 at 12 miles distant, built of firestone, which hold 50 cords each. It requires 8 men for the 13 kilns. These 13 kilns can make 22 turns a year. Working so fast makes it difficult to burn the charcoal thoroughly, so that they usually run only 18 kilns a year. It requires 13 days to fill, burn, and empty a 35-cord kiln. It takes one day to fill, and one to empty it.

In Utah the charcoal is packed in bags, containing 2 to 3 bushels, which are hooked up under an opening 18 inches square in a table 3 feet high. This table is 4 feet square on the top. The charcoal is thrown on to the table and pushed into the bags. Six men will empty a kiln, sack the charcoal, and put it on the cars in one day. The wood is mostly poplar, which is cut dead. The charcoal is very light, and so much was lost by this method that it is now proposed to ship, in cars constructed for the purpose, without packing. It takes 9 to 10 days to burn a kiln. At the end of 5 days all the vents are closed, and they no longer watch it. The fire is extinguished with water; it is not allowed to die entirely. The kilns are whitewashed after every operation. Poplar costs $3 per cord. Pine costs $3.75 per cord. Six men do all the work. The loss in fine coal is very large. The charcoal made from those very soft and often dead woods is very light, so that it crushes by its own weight, and bears transportation very badly. The use of such woods is, however, partially justified by the fact that the coke for the lead furnaces costs in this locality $45 per ton. Thirty-five cords of wood make 1,000 to 1,200 bushels, of 2,680 cubic inches each, of charcoal, or about 45 bushels to the cord. In 1875 the contract was made to deliver at American Fork at 18 cents a bushel.

It seems to be very generally conceded in the Eastern States that the conical kilns holding from 25 to 35 cords are the most profitable. They are less expensive in construction, more easily filled, cheaper to manage, give a better yield, and can be turned more frequently than any of the other varieties of kilns.

STATISTICS OF CONICAL FURNACES.

Diameter or length, inside in the bottom...	28 feet.
Height to spring of arch	19½ feet.
Capacity in cords	25
Number of thousand brick................	33
Number of vents	94
Weight of cast iron vent-holes, each	14 lb.
Pounds of cast iron....	3,000
Pounds of wrought iron	1,000

Charging.			Burning.			Cooling.	Discharging.			Per Cent. of Brands.
Time.	Days' Work.		Time.	Days' Work.		Time.	Time.	Days' Work.		
Days of 10 hrs.	Men.	Horses.	Days of 10 hrs.	Men.	Horses.	Days of 24 hrs.	Days of 10 hrs.	Men.	Horses.	
1	6	1	24 hrs. 4 days and nights.*	1	0	3	1	4	2	5

*A man remains about the kiln all the time.

Cost per hundred bushels............	$0 85
Foundation 50 P. of stone, 3 to 4 feet are required, costs...............	100 00
Bricks $5.50 per M., laying in wall $4.50 per M	320 00
Cast iron for frames, vent-holes, etc., 1 ton....	75 00
Total cost of furnace	$495 85

At Plattsburg, in 1879, it cost $7.50, on Lake George $7, and in a few localities in Vermont $6 per thousand bushels to fill, burn, and empty; the average will be from 6 to 7 cents.

The per cent. of brands in a well-burned kiln will be from one cord in 17·5 cords to one in 18·5. It takes for a 50 cord kiln 12 days, for a 35-cord kiln 9 days. The charging requires one day for four men for 35 cords, and one day for five and six men for 50 cords. Two horses are used for the 35 cord kiln at Plattsburg, but the whole work is done by men with wood barrows.

	50 cords.	35 cords.
Days charging	1	1
Men employed charging................	5 to 6	4
Horses used..........................	barrows	2
Number of days burning..............	10	6 to 7
" of men employed burning	1	1
" of days discharging	1	1
" of men discharging...........	3 to 4	2
" of horses......	2	2
Yield of wood in bushels...............	50	50
No. of bushels of charcoal to cord wood.	50	
Weight of bushel................	20 lb.	soft, 11 to 14 hard, 15 to 19

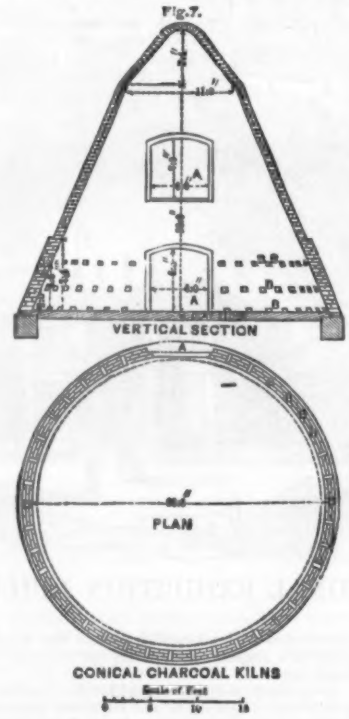
The cost of these kilns will vary with the locality, depending on the local cost of the materials used. It will cost about $500 to build a conical kiln, of from 35 to 50 cords, in Plattsburg, and about $600 in Michigan, with brick at $17.50 per thousand. There seems to be no doubt that the Plattsburg kiln, with iron vent-holes, is the best type of all the kilns.—*Min. and Sci. Press.*

[NATURE.]

PROFESSOR NILSSON.

THE oldest naturalist in the world, as respects both age and the priority of his writings, has now left it. S. Nilsson of Lund, in Sweden, was born in 1787 and therefore was nearly a centenarian at the time of his death. His earliest publication was in 1812, being a paper on the various methods of classifying the mammalia; and in every subsequent year he enriched the scientific literature of his own and other countries. The *Annals and Magazine of Natural History* and the reports of the British Association for the advancement of Science, for instance, contained several articles from his experienced pen. He especially devoted himself to the fauna of Scandinavia, and became the pioneer

Fig. 7.



CONICAL CHARCOAL KILNS

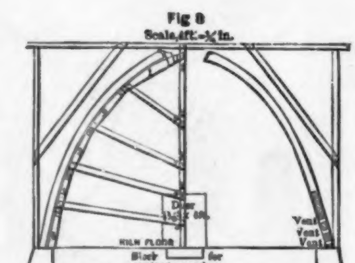
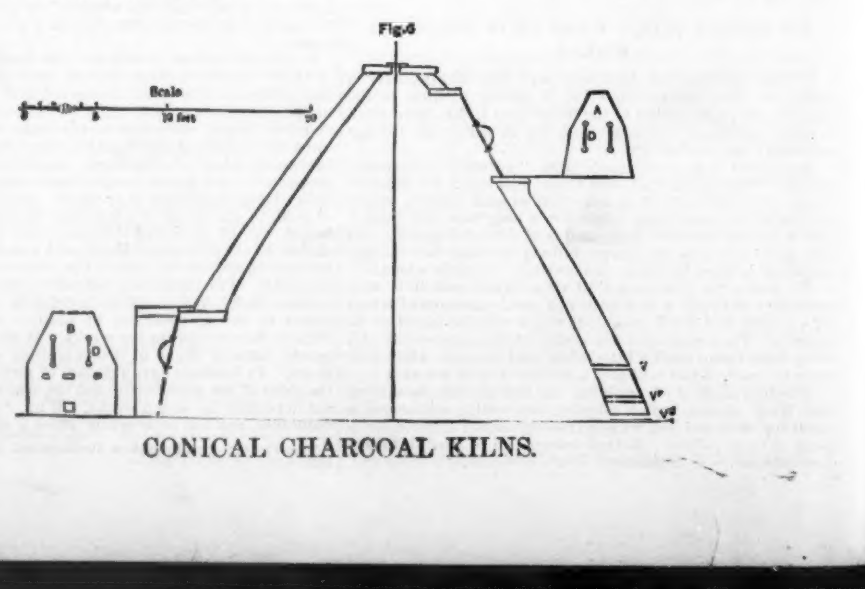


Fig. 6



CONICAL CHARCOAL KILNS.

of that host of naturalists who have so ably distinguished themselves by similar researches and publications. He was a zoologist, palæontologist, anthropologist, ethnologist, and antiquary. *Nihil tetigit quod non ornavit.*

His works consisted chiefly of scattered papers; but in 1822 he published his "Historia Molluscorum Sueciæ Terrestrium et Fluviatilium," which has still a standard reputation. As it did not include the marine or Baltic mollusca, the gap was twenty-four years afterward more than filled up by the eminent Prof. Loven; and that department of the Scandinavian fauna has now, through the continual labors of the late Prof. Sars and his no less eminent son, Dr. Danielssen, Mr. Herman Friele, the Fraulein Esmark, Dr. Westerlund, the late Mr. Malm and his son, Prof. Steenstrup, the late Dr. Mörch, Dr. Berg, Dr. Collin, and many other conchologists, received as great a degree of attention as has been bestowed on any region of the earth's surface and its circumjacent seas.

The subject of this memoir was, at the last-mentioned date (1822), Regius Professor in the Academy of Lund, and the Director of the Museum of Natural History there. One of his former pupils, Prof. Otto Torell, is well-known to all naturalists by his exploration of Spitzbergen, and his present position as the Director of the Geological Survey of India.

We ought to be thankful in recollecting that other veterans of science are still among us, viz., Professors Owen and Milne Edwards at the age of eighty-three and Dr. Isaac Lea, in his ninety-third year. The study of natural history is evidently conducive to longevity.

J. GWYN JEFFREYS.

[BULLETIN OF THE UNITED STATES FISH COMMISSION.]

REARING OYSTERS FROM ARTIFICIALLY FERTILIZED EGGS, TOGETHER WITH NOTES ON POND-CULTURE, ETC.

By JOHN A. RYDER.

THE desirability of testing the breeding of oysters in ponds in the United States, as practiced for many years past in France, has long been a desideratum.

In order to test the feasibility of such a method on a scale large enough to give us practical results, an arrangement to carry out such a scheme was finally effected with the Eastern Shore Oyster Company in June of the present year. The beds near where the work was undertaken are owned by Messrs. Pierce & Shepard, who afforded the writer every opportunity to carry on his investigations, and also aided him very materially in the work of experiment. A pond was excavated in the salt marsh on the shore of Chincoteague Bay, on a farm situated at a distance of about two miles from the village of Stockton, Worcester County, Maryland. This pond covered an area of about 50 squre yards, and was connected with the bay by a trench or canal about 10 feet in length, 2 feet in width, and 3½ feet in depth, which last was the same as that of the pond itself.

The water which supplies this pond was filtered through a permeable, porous gate, or diaphragm, which was placed in the trench connecting the pond with the bay, and no water was allowed to enter the pond which had not been first filtered through this diaphragm.

The diaphragm itself was constructed of boards perforated with auger holes, and lined on the inside with gunny-cloth or sacking; and the space between the perforated boards filled with sharp, clean sand. The space between the boards was about two inches; through this the tide ebbed and flowed, giving a rise and fall of from four to six inches during the interval between successive tides.

This apparatus, if it may be called such, constituted the receptacle into which the artificially fertilized eggs of a number of oysters were introduced every two or three days.

It was supposed, when the experiment was commenced, that some difficulty would be experienced with a rise of temperature in the pond in excess of that found in the bay, because the water was kept confined and still, and constantly exposed to the direct rays of the mid-day sun. But to our surprise and gratification it was learned that the temperature in the pond and in the bay was precisely the same at every observation which was made in order to test this question.

Another question also arose in our minds as to whether it might not be that the water in the pond might become less salt than that in the open bay; in other words, that its specific gravity would be less than that of the water in the bay, owing to leeching from the banks of the pond in addition to that precipitated during rains.

To our great satisfaction we were also agreeably disappointed to find that the specific gravity of the water in the pond remained steadily about the same as that found to prevail in the bay. The specific gravity in the pond was 1·018, and 1·020 at times in the bay, to as low as 1·0175, and the fluctuation of the specific gravity of the water in the pond was found to be about the same as in the bay.

At the head of the creek the specific gravity of the water was about 1·010. In this situation a good many oysters were living and growing; but even this density is not so low as that prevalent in the waters of St. Jerome's Creek, where it fluctuates between 1·007 and 1·010, and where excellent oysters are grown.

From numerous observations and considerations based upon the facts of distribution, it is believed that the oyster in all cases thrives best in waters of a specific gravity about such as has been indicated above, or from 1·007 to 1·020.

Another equally important point to settle was whether a sufficient amount of food would be generated in the pond to supply any young or old oysters with nourishment. To our satisfaction we found immediately after the diaphragm had been placed in the trench that the confined waters of the pond acquired a distinctly brownish-green tint, which we at first supposed was due to particles of dead, brown organic matter. A microscopical investigation of the water showed that in this we were in error, and that the brown color of the water was largely due to the presence of innumerable microscopical plants, consisting largely of diatoms, having brownish contents. It was also found that immense multitudes of very small monads, with long flagella, would collect upon floating chips and light objects at the surface of the water during the warm mid-day hours. It seems, therefore, evident that food was generated in abundance here, and greatly in excess of what may be found in the open bay, and that one of the most important conditions for the success of our experiment had been established.

The final results fully confirmed this conclusion, inasmuch as we found that spat grew just as rapidly in the pond as in the waters of the open bay. There is, moreover, no reason to suppose that it would not grow to a marketable size just as certainly as spat collected in the natural way.

COLLECTORS.

The collectors used in our experiment were of the simplest possible character, the object being to make the experiment as practical in character as possible. To this end stakes were driven into the bottom of the pond, extending above the surface some distance, to which oyster shells, with holes punched through, were attached after being strung upon galvanized iron wire. A number of these simple collectors were placed in the pond, each set being marked with the date on which they were placed in position, in order to afford data for a more detailed study of the results of the experiment.

The first collectors of the kind described were placed in position upon the same day when the first spawn was poured into the pond. This occurred on the 7th of July last.

Other collectors were then put down at odd dates during the remainder of the month of July. The care of this portion of the experiment, together with the spawning of the oysters themselves, was mostly in the hands of Mr. H. H. Pierce, whose share in the work was, to say the least, as important as my own.

METHODS OF TAKING AND INTRODUCING THE SPAWN INTO THE POND.

The oysters used for the purpose of spawning were taken from the vicinity of the oyster house, which stood only about twenty yards from the pond, besides others which were obtained from the deeper waters of the adjacent bay.

It was found that the eggs of those from the shallow water near the pond were as readily fertilized as those from the deeper water, and no difficulty was experienced at any time until toward the latter part of July in obtaining an abundance of good spawn for our experiments.

The oysters from which spawn was obtained were carefully opened by removing the right valve and allowing the soft parts of the animal to remain attached by the muscle to the left one. The spawn itself was then pressed out of the generative organs by means of a pipette gently stroked over the gland and out along the course of the efferent ducts, so as to force the spawn out into the upper gill chamber, as described in previous publications by the writer.

The sexes were distinguished apart very easily by what the writer has described as the "drop test," which consists simply in dropping the spawn from a pipette into a dish of clean sea water and watching the kind of cloud which it forms after it strikes the water. Invariably, if the specimen was a female, the eggs would break up into a granular cloud which could be very readily seen to be composed of very minute whitish bodies if the transparent vessel was held up so as to look down through it upon a dark ground below.

In case the specimen was a male, the drop of milt would not so readily break up, but would exhibit a somewhat glairy consistency; and if the drop was stirred in the water it would break up into wisps and streaks, so as to appear, on a small scale, like a series of minute mare's tail clouds such as are seen in the sky at times. This test was found so practicable that we are able to readily teach a novice how to distinguish the sexes apart in one lesson.

The method of taking the spawn was just as easily learned by Mr. Pierce and Mr. Shepard, both of whom soon became as expert as the writer in the practice of the art of taking oyster spawn. The spawn so taken was mixed together in a small dish. The milt and eggs placed in contact at once were thoroughly stirred together and poured from time to time, as the water became milky in the small glass collecting vessel, into a wooden pail. This was repeated until it was believed that a sufficient amount of spawn was mixed with the water in the pail, which was then taken and poured into the pond at different points, in order to distribute it over as great an area as possible.

Before the spawn was poured into the pond, however, it was allowed to stand in the pail from three to five hours, in order to give it a chance to develop to the swimming stage of the embryo. Fresh supplies of water were also added once or twice during this time to that in the pail in which the spawn was originally taken.

This briefly describes the processes used in conducting our experiment; and while it bears a strong resemblance to the method used by Mr. Brandely, it is really very different in that he had a second pond at a higher level from which supplies of fresh water were drawn through a sponge filter. In our case nothing of the kind was used; we depended absolutely upon nothing else than the rise and fall of the tide for the renewal of the water in the pond. We did, however, use a diaphragm through which the water could pass and repass, somewhat similar to that used by the French experimenter. The method used at Stockton was, however, essentially the same as the apparatus devised by the writer in 1880 and 1881, but which was designed and made on such a small scale and under such unfavorable conditions that no practical results were achieved.

RESULTS OF THE EXPERIMENT.

On the 22d day of August, or 46 days after the beginning of our experiment, Mr. Pierce sent me by mail a series of shells taken from the collectors, which had been placed in the pond at various dates during the month of July, and which showed young oysters or spat attached, ranging from one-fourth to three-fourths of an inch in diameter, demonstrating conclusively that the young would grow just as rapidly in our pond as in the waters of the open bay. Of this last fact I am positively assured on the ground of previous observations made during the three preceding seasons.

We are therefore prepared to assert that it is perfectly feasible to rear oysters from artificially fertilized eggs, and, so far as I can judge, quite as successfully as by the method of sowing shells on the bottom, now largely practiced on the cost of Connecticut in the waters of Long Island Sound. While our experiment has not shown that we could get a greater set of spat than that ordinarily obtained under natural conditions on planted shells, the experiment has settled several questions which are of the greatest importance in the practical work of oyster culture.

One of the difficulties encountered was the same as that met with in shell planting in the open waters, namely, the accumulation of slime and ooze on the surface of the collectors, which is so deadly to the infant oyster when it is from one five-hundredth to one-ninetieth of an inch in diameter, a very slight quantity of sediment serving at this time to smother the infant mollusk and arrest the flow of water through its tiny gills, thus producing death by asphyxia.

THE FOOD OF YOUNG OYSTERS.

This slime I have determined, during the previous seasons, to be largely composed of the very lowest vegetable organisms, namely, *bacteria*, or those plants constantly associated with putrefactive processes, and even accused of being the proximate or remote causes of contagious and infectious diseases in man and the lower animals.

Any one, however, who has carefully studied the feeding habits of the young oyster is soon convinced that it is upon these very low and minute forms that the animal largely depends for food. In fact, it is possible to frequently find young oysters in the stomachs of which multitudes of these minute plants are rotating under the impulse of the vibratile cilia with which the stomach is lined; the stomach itself being a cavity not over the one four-thousandth of an inch in diameter, will give some idea of the minuteness of the food required to nourish so tiny a creature.

It appears that in practice it will be impossible for us ever to provide against the generation of minute organisms which form the slimy coating of fixed objects used as collectors in the water. But from the foregoing considerations it would appear that the removal of the slime, or the prevention of its deposit, is not altogether desirable, in view of the fact that the minute plants comprising a large part of it form an important element in the development of the young, serving, as we have seen, to nourish it during its infant life.

UTILITY OF THE EXPERIMENT.

The practical utility of the experiment, in the writer's estimation, consists in this, that it proves that ponds or inclosed areas of water may be readily utilized on the eastern cost of the United States for cultivating oysters in the same way as is practiced in France and other foreign countries. In fact, there are many thousands of acres of salt marsh all along the eastern coasts of the States of Virginia, Maryland, Delaware, New Jersey, and perhaps New York, and Chesapeake, Delaware, and Chincoteague Bays, which could be readily converted into permanent and profitable planting grounds for the cultivation of oysters.

The great advantage of this method would be that the persons constructing the inclosures or digging out ponds on their own territory, would be absolutely protected by law from the incursions of the lawless tongers whose rights and privileges are not yet as clearly defined in some of the States as they should be. The method would also be of advantage from the fact that inclosed areas properly constructed are more accessible—in fact, could be so arranged as to be worked without the use of boats. It would also be found that oysters would fatten and come into condition for market at a relatively much earlier time in the season than those planted in open, unconfined waters, where cold currents interfere with the abundant development of food.

This view is borne out by the fact that green-gilled oysters are invariably fat, and are usually found at the end of summer in more or less confined waters, or under such conditions as would obtain in inclosed areas in some degrees similar to the one used in our experiment at Stockton. In truth, the writer is now confirmed in the belief that the green-gilled condition is due to an abundance of green microscopic food, which is absorbed in large quantities so as to tint the juices and finally the blood-cells of the animal, and that these green organisms are multiplied under just the conditions afforded by more or less completely inclosed ponds or areas of brackish water.

THE BEST COLLECTORS FOR MUDDY WATER.

The collectors best adapted for waters which contain a large amount of organic matter in suspension are evidently brush or stakes supporting strings of oyster shells strung on wire, because the tide will constantly tend to sweep the accumulated sediment off the surfaces of the twigs and shells. Such collectors should of course be put into the water upright, so as to cause the collecting surfaces to be far above the bottom, which is usually covered to a depth of from a few inches to several feet with black ooze or mud in such situations. The brush should be thrust with the main stem down into the mud far enough to support the branched top against the tide, and also be so placed as to bring the top below low water. The stakes, with their load of shells, should be arranged in a similar way.

These two forms of collectors seem to me to be the cheapest and most available in the practical work of spat collecting where the water contains much sediment and the bottom is too deeply covered with ooze to make shell planting profitable. Where the ooze is too deep, shells will rapidly sink into it so as to be entirely covered and afford no surface to which young spat can attach itself and grow.

By means of some such method a large area can be rendered profitable as planting ground which is now utterly barren and useless for such purposes.

These are mere suggestions, but I am fully convinced from the facts which have come under my observation during the last three years that they are very important ones, because in many cases it is evident that all that is needed to get spat is to afford surfaces upon which it may attach itself in those situations where the bottom is deeply covered with mud and where the fixation of spat and the establishment of oyster-beds is often, without such provision, a sheer impossibility. The importance of placing collectors in such places must, therefore, be evident to the intelligence of the most ordinary person.

OBSERVATIONS UPON OYSTER SPAT AT WOOD'S HOLL, MASS.

In the early part of the month of August my attention was called to a number of wooden buoys lying on the beach near the lighthouse establishment at Wood's Holl, and which had been taken from the upper end of Buzzard's Bay, near Cohasset. These wooden buoys were replaced by others during the early part of July. Upon examining the surfaces of a number of those which had been removed from their former position, it was found that they were covered with a remarkable "set" of young oysters ranging in size from one-ninetieth to one-eighth of an inch. In some cases as many as twenty-five young oysters might have been counted on a surface of one square inch. Every available clean surface was covered more thickly than I had ever observed anywhere in either the Chesapeake or Chincoteague Bays. It was evident that the attachment of spat in this case would have been very great in that vicinity had there been an abundance of collectors placed in position in the early part of the month of July or the latter end of June, the time which seems to be the most important period at which to place collecting apparatus in position, as shown by my observations in Chincoteague Bay, where I am satisfied that little or no spat caught on any sort of collecting apparatus previous to the 1st of July, although oysters in the vicinity may have been spawning much earlier.

This point was determined by the following method:

Upon examining the shells and old oysters in Chincoteague Bay, about the end of June, I soon became convinced that all the young oysters then visible belonged to the set of last season. Two facts served to prove this: the first was that the larval shell was eroded or eaten off the beaks of the spat shells by the carbonic acid in solution in the water. It was also evident that these young oysters had made a second growth which belonged to this year, because a distinct offset

or line indicating as much could be detected on the outside of the upper valve of every specimen which was examined. These data serve to finally fix the approximate time at which the set of spat occurs in the latitude of Chincoteague Bay. But it is evident that this time is somewhat later in Buzzard's Bay, on the coast of Massachusetts, from the fact that the spat observed in that neighborhood averaged much smaller than that from the more southern waters alluded to above.

THE SET OF SPAT IN BUZZARD'S BAY.

During the second week of August, in company with Vinal N. Edwards, I made a trip on the steam launch from Wood's Holl to the head of Buzzard's Bay to examine the set of spat in that region, having been encouraged to do so by what I had witnessed on the buoys brought in from the neighborhood some weeks before. Going to a point of land covered largely by coarse gravel, we found that a planter had sown a considerable area with clam and oyster shells. It was ascertained that immense numbers of spat had been caught, ranging from about one-sixteenth to three-eighths of an inch in diameter; the average size was probably about three-sixteenths of an inch. In some cases a single shell was found to give attachment to more than 100 young oysters of the sizes mentioned.

It is evident, of course, that a large proportion of these, owing to their being so crowded, could not possibly survive much beyond the time when they would grow large enough to crowd each other and come in contact at their edges. Many would necessarily be killed in the course of growth from this cause, so that it follows that it is not desirable that spat should catch so thickly as in this case. Indeed, it is probable that a set of three to five young oysters on one shell has a a better chance to survive than a much larger number. But the question here raised can only be settled by future observations made by competent persons, though it is true that the author has made some observations which afford almost positive proof that young oysters are sometimes killed by overcrowding while still quite small.

THE SET OF SPAT IN 1883 IN DIFFERENT OTHER LOCALITIES.

The set of spat on planted shells, and on all kinds of objects in the water, seems to have been unusually large during the past summer. Reports from various sources indicate as much; since it is a fact that shells planted in Buzzard's Bay, as noted above, have had in some places an unusual crop of young oysters fixed to them.

In Long Island Sound the planted oyster shells have had an enormous number of spat attached, as is shown by a report in the *Hartford Times.*

The shells in the vicinity of New Haven, according to this report, cost seven cents per bushel. The firm of Smith Brothers, who, by the way, sold $30,000 worth of oysters last year, have sown 130,000 bushels of shells on their 350 acres of oyster farm land this year, at a cost of about $17,000. The set upon their shells is an unusually large one, and has caused considerable excitement among the oystermen in the vicinity.

The Smith Brothers tried only four of their beds. One of these was sown with shells by a younger brother last spring, who put his mite of $500 into the work. His lot seemed to be the most thickly covered with spat; and one of the firm offered him $3,000 in hard cash for it, but he declined the proffer with thanks.

In Chincoteague Bay Messrs. Pierce & Shepard have also sown some ground with shells this season. The result has been most gratifying, in that a very good set has been found on them.

In the southern waters, especially in Chesapeake Bay, the sowing of shells has not been practiced to the extent that it probably will be in the course of the next few years, when the method is more favorably known.

One advantage of oyster culture in the Chesapeake over that practiced in Long Island Sound and the more northern waters is, I believe, to be noted in the fact that star fishes are not as abundant; nor have I ever heard that they were as destructive as they are farther north. The experience of Messrs Pierce & Shepard proves conclusively that what applies to the practice of shell planting in Long Island Sound is equally applicable in the waters of Chincoteague Bay, and inferentially in those of the Chesapeake.

ENEMIES.

There are some "drills," or boring whelks, which are found in Chincoteague Bay, that bore into the shells of living oysters and cause some destruction, but not, so far as I could learn, to a serious extent.

These molluscan enemies of the oyster are found more or less abundantly in all waters in which oyster culture is practiced, and are probably one of the necessary evils to be encountered in the business, together with the boring sponge, which eats into the shells and which seems to be found in greater or less abundance wherever oysters grow.

PROPER CONDITIONS.

The idea that a rough, ragged surface is necessary upon which oyster fry may readily catch is a fallacy. The prime condition that is necessary in order that the fry may adhere and live, to any surface put down for collecting purposes, is that that surface shall be clean and remain so long enough for the young oyster to get large enough to take care of itself in some measure.

It is doubtless true that where oyster shells are pretty thickly sown, the interstices between the shells serve to some extent to retain the fry while they are still in the swimming stage; but rough surfaces are not at all essential, in that we find spat sets as thickly on the smooth inner surface of oyster shells as upon the rough outer one.

METAMORPHOSIS OF THE FRY.

When the young oyster ceases to swim, and attaches itself, it undoubtedly grows considerably after the time of attachment before its valves lose the perfect symmetry of the larval stage. This has been proved by the examinations which I have made of the spat caught on the buoys brought to Wood's Holl. This is also evidence that the writer is probably correct in his statement that the young oyster attaches very soon, or within 24 to 48 hours after the eggs have been fertilized, as announced in his paper on the "Fixation of the Fry of the Oyster," published in "Bulletin United States Fish Commission," vol. ii., 1882, pp. 383 to 387. Another fact confirming this opinion is the circumstance that it is impossible to start the larval shell of the oyster from its surface of attachment, after it has acquired the umbones and before it begins to develop the spat shell, without breaking it. This is proof that the shell of the fry has been glued to its surface of attachment at a very early stage; and it is also a fact that it is invariably the left valve which is undermost, with its beaks directed toward the left side.

COMPARATIVE FREEDOM OF THE WATER FROM SUSPENDED MATTER.

The northern waters where oysters are grown seem to be clearer and less full of suspended particles, at least in Buzzard's Bay than in the Chesapeake. This may be one reason why the spat catches in such abundance in certain places, sticking to gravel, dead shells, bowlders, stones, buoys, and all kinds of fixed objects having clean surfaces. It may be that the water of the Chesapeake, holding more sediment in suspension, is less favorable for the attachment of spat than that of the clearer northern oyster regions. At any rate, the deposition of sediment at some places in the Chesapeake proceeds at an unusually rapid rate, which would naturally, as explained above, interfere with the attachment of the fry. This has suggested to the writer the practicability of transporting small spat from the northern waters to the more southern, inasmuch as it seems that a greater proportion of spat will catch and grow on the same area there than in the south. Certain it is that quite young spat may be transported, say from the Chesapeake to Chincoteague Bay, and survive the journey and grow very rapidly, as I had opportunity to learn during the past summer on the grounds of Messrs. Pierce & Shepard. Whether it would be profitable to transport small spat for long distances, and whether it would survive such a journey, could, of course, only be learned by actual experiment; but it is possible that the experiment would be worth a trial.

ABSORPTION OF BRACKISH WATER BY SALT WATER OYSTERS.

The growers who carry on the cultivation of the oyster practice in many places what is called "plumping," or puffing up oysters for market by exposing them for a short time to the effects of water fresher than that in which they grew. One party at Franklin City has actually used steam heat in order to warm fresh water to 65° or 70° F., in winter, so as to get the oysters to open their valves and take in enough fresh water to puff up their flesh and give them a better appearance in the market. By this process the animal does not acquire any additional matter except the water, which is taken up in great amount, but it loses a part of its saltness, and, in flavor, becomes more like an oyster from brackish waters.

EFFECT OF SEA WATER ON BRACKISH WATER OYSTERS.

It is a remarkable fact that just the reverse effect will be produced on the flesh of oysters which are carried from brackish into water which is more salt. This was shown by taking some oysters from Buzzard's Bay and bringing them to Wood's Holl, where they were kept supplied with water running from a faucet for several days. At the end of that time the soft parts had shrunken to a remarkable degree, and acquired a toughness and leathery consistency in marked contrast with that observed in the animals before the experiment was tried. These effects are produced, as is well known, by osmotic action.

STORAGE FLOATS.

An ingenious system of floats, which are raised and lowered by means of windlasses, are used in this work by Mr. Conger, of Franklin City, Md. This apparatus is a great convenience in storing oysters temporarily near the oyster houses, where they are packed for market. The floats are 20 to 25 feet long and 7 or 8 feet wide, with a bottom made of strong slats. The windlasses are supported on the tops of four piles driven into the mud in two pairs, one at either end of the float.

ECONOMICAL SIGNIFICANCE OF THE STOCKTON EXPERIMENT.

The success in rearing oysters from the eggs, as practiced at Stockton, the past summer, admits of no doubt whatever; inasmuch as there could be no question as to the identity of the eggs from which the spat which caught on the collectors was derived. No other ova could by any means have gained access to the inclosure, so as to vitiate our results. But this success I do not esteem of as much value as the facts of collateral importance which it has substantiated. These are the following:

First. It has proved that oysters may be grown in inclosed ponds.

Secondly. It has proved that an abundance of food will generate in such inclosures.

Thirdly. It has proved that we can depend upon the tide to renew the waters of such ponds.

Fourthly. It has been shown that the cost of digging out ponds on an extensive sale would be a comparitively inexpensive undertaking, because no digging is required except such as can be done with a spade. The nature of the salt marsh is such that it can be cut into any shape desired; the black muck of the marsh being interpenetrated with great numbers of roots and decayed fibers of vegetable matter which render it tough, so that it can be cut out in solid blocks. About the depth of what would be taken by three superimposed spadefuls is a sufficient excavation for the purposes of pond culture in many places. There are thousands of acres along the eastern coast of the United States of salt marsh lands which are available for pond culture, besides the ground already occupied off-shore; so that the development of the industry seems to be practically unlimited. Wherever the water is fresh enough to grow oysters, and where such marsh lands also exist, the construction of ponds for oyster culture is feasible on just as grand a scale as is now practiced on some parts of the coast of France.

The writer does not think that the rearing of oysters from artificially impregnated eggs will ever be a profitable business, in that it is likely that collecting spat by simple and inexpensive methods, such as the use of brush, shells, gravel, and other cheap, clean materials, will always yield as good results on a large scale as any artificial method could possibly give. But it is possible that we greatly underestimate the value of wholly artificial methods.

NOTICE OF A PARASITE OR COMMENSAL OF THE OYSTER, WITH REMARKS ON ITS DISTRIBUTION.

About a year since, M. Adrien Certes, of 21 Rue de Jouy, Paris, announced, through the pages of the Bulletin of the Zoological Society of France, that he had met with an organism inhabiting the stomach and intestines of the oyster, which presented some remarkable characteristics, and which was allied to a parasite found in the blood of the frog, and to another species found in the intestines of birds.

The writer first noticed this creature in the stomach and intestines of the American oyster during the summer of 1880, and then supposed it to be nothing more than a small vegetable organism allied to *Vibrio*, and has made some allusion to it under that name in his report to the Maryland Commissioner for that year.

M. Certes has since shown that this identification is an error, as well as a later name which the writer had proposed, namely, *Spirillum ostrearum*. A more critical examination has shown that it is often found in great numbers in the stomach, especially at its hinder extremity, in which a singularly transparent rod is embedded. In this place they are sometimes found in vast numbers. They do not seem to be a true parasite, but are rather to be regarded as a messmate, inhabiting the alimentary tract of the oyster. They are very minute, thread-like organisms, which are provided with an extremely delicate narrow frill or membrane, which is wound spirally around the body of the animal. The living creature moves rapidly across the field of the microscope, looking very much like a minute animated spiral spring, rotated with a screw-like motion through the liquids taken from the stomach and gut of the oyster. This creature has been encountered by the author in the contents of the stomachs of oysters in Washington and Philadelphia; also at different places on the shores of the Chesapeake and Chincoteague Bays, and even as far north as Buzzard's Bay. It therefore seems to be a constant inhabitant of the oyster. It has also been found in other portions of Europe besides the place where it was originally found by M. Certes, who first noticed it in oysters taken from the vicinity of Marennes. This gentleman, in a letter to the writer, dated August 7, says that Professor Mobius has also found it in the oysters of the North Sea. The animal found in the American oyster is apparently very similar if not identical with that found in the flat oyster (*Ostrea edulis*) of Europe.

Professor Mobius has published an account of his discovery in No. 134 of the *Zoologischer Anzeiger* of the 19th of March, 1883.

The discovery of this parasite and its subsequent study were made in precisely the same way as by the writer. The contents of the stomach of the oyster were removed by thrusting a pipette or medicine dropper into the mouth of the animal, and drawing out by that means the juices and the microscopic food which the stomach contained. Almost every other oyster examined, and sometimes every one, will be found to be inhabited by this creature; but no ill effects, so far as the writer is aware, are traceable to its presence when infested oysters are consumed by man as food. It seems to be a perfectly harmless commensal or pensioner upon the oyster whose stomach it inhabits.

THE FOOD OF THE OYSTER.

The method of removing the contents of the stomach of the oyster with the pipette is valuable for another very important purpose, namely, to learn the nature of the food which the animal had taken shortly before. This season, while examining oysters in Chincoteague Bay, with this object in view, I found that the adults were guilty of swallowing sometimes as many as 200 of their own young at one meal. These young oysters ranged in size from one five-hundredth to one two-hundredth of an inch in diameter, and already had the shell developed; and the larger ones were found to be themselves feeding, inasmuch as food could be seen in their stomachs.

Besides these young oysters a good many oyster eggs were also found among the contents of the stomach, together with spermatozoa, diatoms, the very youngest stages of barnacles, and the shells or external coverings of a singular infusorian, which was identified as a species of *Tintinnus*. Of this last organism, several thousands of their shells were sometimes met with in the contents of the stomach of a single oyster.

The fact that adult oysters swallow their own young and eggs shows that they may be, in this way, to some extent destructive of their own species.

The investigation of the contents of the stomach and intestines of the oyster by the method already described, on an extensive scale in different localities along the eastern coast of the United States, is important; because it is a well known fact that the flavor of oysters varies or is affected by local causes, which are probably mainly the food and the saline condition of the water in which they grow.

The contents of the stomachs of a great number of individuals could be very readily removed and preserved for investigation by the means which the writer has used. The identification of the minute vegetable and animal remains in such material preserved for study could readily be carried on by specialists versed in the characters presented by the various forms.

Possibly the most important of the food elements of the oyster are diatoms. These free swimming, minute plants are found in vast numbers wherever oysters grow, and are numerous in species; so that the subject would be worthy of the attention of some one who had devoted extensive study to them. By such a course it would be possible to determine whether the diatomaceous flora of a given district where oysters are grown differed essentially from the diatomaceous flora of another; and it might in this way be possible to get at the reason why oysters from different localities differ in flavor.

THE POPULAR DELUSION REGARDING GREEN GILLED OYSTERS.

For many years green-gilled oysters in England and France have been more highly esteemed by the epicure than the white fleshed ones; in consequence of which fact the growers have made every effort to cater to this singular taste. They have also found it a profitable taste to cater to; because the green gilled oysters are higher in price in the markets of Europe than the white fleshed ones. The only place in the United States, so far as the writer is aware, where this taste has been developed is in the city of Norfolk, Va., where it is said that green gilled oysters are worth five cents per quart more than white fleshed ones. The prevalence of this peculiarity in a large proportion of the oysters from the Chesapeake Bay and Rappahannock River last winter was the cause of a serious decrease in the value of the affected product. Every test, chemical, physical, and gastronomical, which has been tried at the instance of various investigators, has shown that the consumption of green gilled oysters is never attended with evil effects. In fact, it has been proved that the green color is in no way due to copper, as has been asserted by ignorant or prejudiced persons. In truth, the color is due to a harmless vegetable coloring matter absorbed from the food upon which the animal feeds, and is very nearly identical in composition with the green coloring material found in the leaves of trees.

It is to be hoped that the public mind may be educated up to the point where they will fully comprehend the fallacy of the belief that the green of oysters is due to copper; because it may be said that any such quantity of a copper salt which would produce the green color of oysters would necessarily be fatal to the animal itself.

To sum up, it may be said that the doctrine that the green color of oysters is due to copper is utterly fallacious, and without a shadow of foundation in fact.

It was formerly believed that the acquisition of the green

color was confined to the oyster, but I have recently learned that the soft and hard clam are both affected under certain conditions and at certain times by a similar alteration in the tint of the gills, which is doubtless due to precisely the same cause as the same condition in the oyster. This is all the more likely, because the food consumed by these two animals is very similar to that consumed by the oyster; but that they should be in any way deteriorated in quality by the acquisition of this green color is in the highest degree improbable.

Wood's Holl, September 4, 1883.

THE AMERICAN AGAVE, OR ALOE.

ABOUT seventy years after the discovery of America—that is, in 1561—Spanish sailors brought a Mexican plant, named by the inhabitants "Maguri," to their home. This plant stands in high estimation with the Mexicans up to the present day, as it provides them with their national drink, "pulque," and they use the fibers for making ropes, cables, fabrics for clothing, etc. The wood is used for building huts, as fuel, and for other purposes. This new giant plant, with its enormous, beautifully-shaped rosette of leaves, created quite an excitement in Europe, and it was named the "Agave," meaning the grand and beautiful; and, as it was introduced from America, it was known as the "American Agave" (*Agave Americana*). It was cultivated in all the border countries of the Mediterranean, where it soon grew wild, and now it enhances the beauty of the scenery of these countries.

About three hundred years ago, in 1583, it first grew in Italy. In Germany and other northern countries it can only be raised in hot-houses, and is used only for decorating gardens, handsome buildings, etc. Agaves have very seldom been brought to bloom in Germany, only four cases being known within the last twenty years—an agave bloomed in the botanical garden at Bonn in 1860, at the garden of Donaueschingen in 1861, in the garden at Freiburg i. B., in 1865, and in the garden of the Prince of Ratibor, at Randnitz, in Upper Silesia, in 1881.

At present an agave is blooming in the garden at Lungnitz, near Dresden. The father of the present gardener, Otto Altendorf, cultivated this plant for twenty-eight years, and his predecessor also cultivated it for a number of years. The age of the plant is estimated at eighty years. The rosette of leaves has a diameter of eight feet; the leaves have round, curved thorns on their edges, and are wound spirally around the thick stem; the oldest leaves are about four feet long, from seven to ten inches wide, and from three to five inches thick.

The plant was removed from the hot-house into the garden in the month of May, and this year the heart or middle leaves were shorter than in previous years. Toward the middle of June these middle leaves began to separate, and an enormous bud grew upward from the middle of the same, which bud had the appearance of an asparagus head, and was covered with closely set, brownish, scaly leaves. This bud grew into a stem very rapidly, and in the beginning increased four inches in length each day. A branch grew from the same, and within three months the main stem was eighteen feet high, and the branch which grew out of the main stem at the middle of its height was about eight feet long. At the base the stem is four inches in diameter, and where the branch grows out the diameter of the stem is about three inches. If the branch had not formed on the stem the latter would probably have been eight feet longer,

BLOOMING AMERICAN AGAVE AT LUNGNITZ, NEAR DRESDEN.

BLOSSOMS OF THE AMERICAN AGAVE.

reaching the height of twenty-six feet. Fifty branches, having about the thickness of a finger, grew from the stems at their upper ends, which branches were from five to seven inches long, and on the ends of the same, blossom buds began to form.

Week after week passed before these blossoms began to develop; but on the 12th of October the first blossom of the lowest bunch opened. After the plant was carried back to its winter quarters in the hot-house the rest of the blossoms opened very rapidly, so that two-thirds of the bunches are now (December 1) in full bloom. The number of blossoms is very large, in some bunches there are as many as from 50 to 80, so that there are more than 3,000 blossoms on the plant. All the blossoms of the entire plant will probably be in bloom by the middle of December. The appearance of the single upright blossoms resembles that of the "day lily" (*hemerocallis*) and the "love-flower" (*agapanthus*). Each blossom is about four inches long, and the calyx, which is about half the length of the blossom, is contracted at the lower part. The blossom has a tubular, bell shape, and its six sections are only separated sufficiently to permit the six stamens to pass out from between the petals. The pistil, with its stumpy, triangular head, gradually increases in length as the blossom opens. The stamens project about

BLOSSOM BUDS OF THE AMERICAN AGAVE.

two inches from the blossom and have a yellow color, giving the entire blossom the appearance of being yellow, whereas it really has an indistinct yellowish-green color. In tropical countries the blossoms have a delightful vanilla odor; but the blossoms of the agave at Lungnitz are devoid of this odor, and on the contrary have an unpleasant animal odor.

After blooming the agave dies. It produces an enormous number of seeds, which are contained in capsules divided into three compartments. Young plants spring up from the roots, but the old plant is lost, and the Lungnitz agave will no longer be an ornament for the garden. In tropical countries agaves blossom earlier, and consequently die sooner; some live only from four to five years; in Mexico, from eight to ten years; in Spain and Italy, about twenty years; and in the northern countries, fifty years or more. It is generally and erroneously stated that the agave blooms only every hundred years, and for that reason it has been called the century plant or century aloe.—*Dr. F. Theile, in the Illustrirte Zeitung.*

[NATURE.]

NORDENSKJOLD'S GREENLAND EXPEDITION OF 1883.

IN a series of letters to Mr. Oscar Dickson, Baron Nordenskjold has given a detailed report of the leading incidents and results of his recent expedition, though it will still be some time ere we can learn what are the full gains to science. The leading novelty of the expedition was, of course, the journey into the interior of Greenland.

We reproduce a sketch map of this journey, which Mr Dickson has been good enough to send us. After mentioning his attempt to approach the southeast coast of Greenland, Nordenskjold says:

The ice much resembled the big rough blocks which are encountered north of Spitzbergen. The surface here carries a cold current which sets the ice on shore. The polar current is, however, not very voluminous; thus in a depth of a couple of fathoms Herr Hamberg discovered, through careful survey, a decided warm current from the south. The depth of the sea was not great, and the bottom consisted of large blocks which tore the trawling net and prevented dredging.

After landing Dr. Nathorst and his party at Waigatz Sound, Nordenskjold went back to Egedesminde, which he reached on June 29. He then proceeds:

The following day I left for Auleitsivik Fiord, from which my expedition was to start. This fiord is about 130 kilometers long, and very narrow in the middle, not unlike a river, which widens at the bottom into a bay, Tessiusarsoak, into which an arm of the inland ice shoots. This remarkable formation, and the great tides which favor this part of Greenland, make the navigation here very difficult. As in most of the Greenland fiords, the sea is deep and free from reefs. A remarkable feature, too, is that icebergs coming athwart the narrows in the fiord cause the water in the bay suddenly to rise some ten to twenty feet. The Esquimaux relate that some years ago a boat with men, women, and dogs was drawn under here by the whirl currents. They are, in consequence, afraid of rowing in the narrows.

In 1870 I had paid a visit to this fiord and examined these difficulties, which I believed would have increased rather than otherwise during the last thirteen years, through those changes which so often occur in the position and size of the moving glaciers which shoot down from the inland ice. On inquiry I was told that no European had been in the fiord since 1870. Still my knowledge of the feasibility of getting at least some 50 kilometers inland from this spot decided me to select it as my *point d'appui*.

On July 1 the Sophia anchored in the bay just north of the inland ice. We found here a splendid harbor with clay bottom, some seven fathoms deep, surrounded by gneiss rocks from 600 to 1,000 feet in height, the sides of which are in some places covered with low but close shrubs, or clothed with some species of willow, mosses, and lichen, which, when we arrived, were ornamented with a quantity of magnificent blossoms. From one of the slopes a torrent descended, the temperature of which was 12·3° C. The weather was fine, the sky cloudless, and the air very dry. July 1 to 3 were employed in making preparations for the ice journey, while the naturalists made excursions to various places in order to collect objects relating to the conditions of the country. On the night of the third everything was ready for a start, and after some difficulty in reaching the spot where the baggage was, we were fairly off. The spot from which we set out on the journey was only five kilometers from the actual shore, and situated below a little lake into which a number of glacier rivers fell. We proceeded up the river in a Berton boat purchased in England. On the night of the 4th we camped for the first time on the ice. The expedition consisted of nine men besides myself. After a great deal of hard work in getting the sledges over the ice, which was here very rough, we found on the morning of the 5th that it was impossible to proceed eastward, but were compelled to return to the border of the ice, and then continue to the north or northeast until finding smoother ice. This first part of the ice was furrowed by deep crevasses and ravines, causing us much trouble. We covered, however, a good distance that day, and pitched our tent near a land ridge in the ice 240 m. above the sea.* On July 6 I sent the Lapp Lars forward to reconnoiter, and he reported that it was still impossible to proceed eastward, but if we marched for a day or so to the north we would find the country accessible to the east. As I feared, however, the impossibility of dragging the sledges with the weight on them over the rough ice, I selected provisions, etc., for forty-five days and left the rest in a depot in the ice. We now resumed the march. It was very interesting to witness the great care with which the Lapps proceeded among the ice ravines, how easily they traced a road discovered, and with what precision they selected the least difficult track.

The Lapp Lars carried, instead of an alpenstock, a wooden club, with which he had slain more than 25 brown bears, full of marks from their teeth, and his eyes sparkled at the thought of encountering a white one. On the night of the 6th we held our third camp on the ice, and now several officers and men from the Sophia, who had accompanied us thus far, left us. Besides the most advantageous requisites for such a journey, we had with us a cooking apparatus for petroleum, and here I beg to say that I found this kind of oil far more suitable than train or vegetable oils, which I had used on my former expeditions, and I recommend the same most warmly to Arctic explorers. Of scientific instruments I may mention compasses, two chronometers, a circle by Pistor and Martin, a small sextant, in case of the former being damaged, a mercury horizon, three aneroid barometers, thermometers, magnets for the study of the clay deposit in the snow, a topographical board, a photographic apparatus, blowpipes, flasks, nautical tables, etc. The sledges "kalkar," six in number, were of the same kind as those on which Swedish peasant women being their wares to market; the harness was made so strong that it would hold a man in case of his falling into a crevasse. In addition to these things we had a Manila rope specially spun for the expedition at the Alpine purveyor's in Paris. The food supplied per day may perhaps interest explorers. It was—breakfast: coffee, bread, butter, and cheese (no meat or bacon); dinner: 42 cubic c. m. Swedish corn brandy (*brænvin*), bread, ham or corned beef, with sardines; supper: preserved meat, Swedish or Australian. Sometimes preserved soup was served with dried vegetables. Five men were teetotalers, but there was no need of supplying them with extra rations. For cooking 0·7 liter of spirits was consumed per day. Our whole baggage weighed a ton, a weight which might easily have been drawn across a smooth snow or ice field but which was very difficult of transporting over the rough and cut up surface we had to traverse. Our daily march between July 7 and 9, was, therefore, not great, viz., 5 kilometers a day. In addition to the crevasses and ravines, we encountered innumerable rivers, swift, and with steep banks which were difficult of crossing, which was generally accomplished by laying three alpenstocks across them. If I had not selected these of the toughest wood obtainable, we should often have had to make detours of many kilometers.

On these days we found on several occasions large bones of reindeer on the snow, and it was but a natural and pardonable conclusion to arrive at, that they were those of animals who had fallen in their wandering over the "Sahara of the Arctic regions." But that good signs are not always true ones we soon discovered.

During the entire journey we had great difficulty in finding suitable camping places. Thus either the ice was so rough that there was not a square large enough for our tent, or else the surface was so covered with cavities, which I will fully describe later on, that it was necessary to pitch it over some hundred smaller, and a dozen larger, round hollows, one to three feet deep, filled with water, or else to rise it on a snow drift so loose and impregnated with water that one's feet became wet even in the tent. An exception to this was the place where we camped on July 9, viz., camping-place No. 6. We encountered here a small ice-plain, surrounded by little rivers, and almost free from cavities, some thirty meters square. All the rivers flowed into a small lake near us, the water from which rushed with a loud roar through a short but strong current into an enormous abyss in the ice plateau. The river rushed close to our tent, through a deep hollow, the sides of which were formed of magnificent perpendicular banks of ice. I had the spot photographed, but neither picture nor description can give the faintest idea of the impressive scene, viz., a perfectly hewn aqueduct as if cut by human hand in the finest marble, without flaw or blemish. Even the Lapps and the sailors stood on the bank lost in admiration.

At first we had followed the plan of bringing the baggage forward in two relays, but, finding this very fatiguing, I decided to bring all with us at once. I found this to answer better. On July 10 we covered thus nine and a half, on the 11th ten, and on the 12th eleven kilometers. The road was now much better than before, although stiff enough. An exception to this was, however, formed by the part we traversed on the 11th, when we proceeded alongside a big river, the southern bank of which formed a comparatively smooth ice plain, or rather ice road, with valleys, hills, cavities, or crevasses, some five to ten kilometers in width, and them, however, with the assurance that I would find the way back by means of a compass and solar measurements. In spite of this the Lapps easily traced our route and our old camps with an accuracy quite marvelous.

During our outward journey I determined the site of each camp astronomically, and thus the distances which, when the determinations have been calculated, will be given on the map to be drawn of the journey will be absolutely correct. But the distances covered by the Lapps have been made according to their own judgment. The kilometers we covered every day, including the numerous detours, were ascertained by two pedometers.

Up to the 9th camp we were favored by the finest weather, generally with a slight southeast wind, cloudless sky, and a temperature in the shade, three feet above the ice, of 2° to 8° C., and in the sun of even 20° C. The center of the sun's disk sank in this spot for the first time below the horizon on July 15, and the upper rim, if allowance is made for refraction, on July 21. After the middle of July, when at an elevation of 4,000 to 7,000 feet, the nights became very cold, the thermometer sinking to 15° and 18° below freezing-point, of Celsius.

The constant sunshine by day and night, reflected from every object around, soon began to affect our eyes, more so, perhaps because we had neglected to adopt snow-spectacles at the outset of our journey, and snow-blindness became manifest, with its attendant cutting pains. Fortunately Dr. Berlin soon arrested this malady, which has brought so many journeys in the Arctic regions to a close, by distributing snow-spectacles and by inoculating a solution of zinc vitriol in the blood stained eyes. Another malady—if not so dangerous, at all events quite as painful—was caused by the sunshine in the dry, transparent, and thin air on the skin of the face. It produced a vivid redness and a perspiration with large, burning blisters, which, shriveling up, caused the skin of the nose, ears, and cheeks to fall off in large patches. This was repeated several times, and the pain increased by the effect of the cold morning air on the newly formed skin. Any similar effect the sun has not in the tropics. With the exception of these complaints, none of us suffered any illness.

On July 13 we covered thirteen, on the 14th ten, and the 15th fourteen, kilometers (9th to 12th camps). At first the road gradually rose, and we then came to a plain which I in error believed was the crest of the inland ice. The aneroids, however, showed that we were still ascending; thus the 9th camp lies 753, the 10th 877, the 11th 884, and the 12th 965 meters above the sea. Our road was still crossed by swift and strong rivers, but the ice became more smooth, while the kryokonite cavities became more and more troublesome. This

The heights are given provisionally in meters. Swedish mile=6·64 English miles.

five kilometers in length, This plain was in several places beautifully colored with "red" snow, especially along the banks of the river. It was the only spot on the whole inland ice where we found "red" snow or ice in any quantity. Even yellow-brown ice was seen in some places, but, on the other hand, ice colored grayish-brown or grayish-green, partly by kryokonite, and partly by organisms, was so common that they generally gave color to the ice landscape.

Even on July 12—between camps Nos. 7 and 8—we found blades of grass, leaves of the dwarf-birch, willows, crackberry, and pyrola, with those of other Greenland flora, on the snow. At first we believed they had been carried hither from the interior, but that this was not the case was demonstrated by the circumstance that none was found east of camp No. 9. The only animals we discovered on the ice were, besides the few birds seen on our return journey, a small worm which lives on the various ice algæ, and thus really belongs to the fauna of the inland ice, and two storm driven birds from the shore. I had particularly requested each man to be on the lookout for stones on the ice, but after a journey of about half a kilometer from the ice border no stone was found on the surface, not even one as large as a pin's point. But the quantity of clay dust ("kryokonite") deposited on the ice was very great; I believe several hundred tons per square kilometer.

We now ascended very rapidly, as will be seen from the subjoined statement of our camps:

3d	camp,	300	meters above the sea.	
4th	"	355	"	"
5th	"	374	"	"
6th	"	382	"	"
7th	"	451	"	"
8th	"	546	"	"
9th	"	753	"	"

The 9th camp lay on the west side of an ice ridge close by a small, shallow lake, the water from which gathered as usual into a big river, which disappeared in an abyss with azure colored sides. From this spot we had a fine view of the country to the west, and saw even the sea shining forth between the lofty peaks on the coast; but when we reached east of this ice ridge the country was seen no more, and the horizon was formed of ice only.

Through an optical illusion, dependent on the mirage of the ice horizon, it appeared to us as if were proceeding on the bottom of a shallow, saucer-shaped cavity. It was thus impossible to decide whether we walked up or down hill, and this formed a constant source of discussion between us, which could only be decided by the heaviness of the sledges in the harness. The Lapps, who seemed to consider it their sole business that we should not be lost on the ice, came to me in great anxiety, and stated that they had no more landmarks, and would not be responsible for our return. I satisfied was made more unpleasant by rain which began to fall on the afternoon of July 13, with a heavy wind from southeast. It continued all the night, and the next morning turned into a snowstorm. We all got very wet, but consoled ourselves with the thought that the storm coming from southeast argued well for an ice free interior. When it cleared a little we strained our eyes to trace any mountains which would break the ice horizon around us, which everywhere was as level as that of the sea. The desire soon "to be *there*" was as fervent as that of the searchers of the Eldorado of yore, and the sailors and the Lapps had no shadow of doubt as to the existence of an ice free interior. And at noon, before reaching camp No. 12, everybody fancied he could distinguish mountains far away to the east. They appeared to remain perfectly stationary as the clouds drifted past them, a sure sign, we thought, of its not being a mass of clouds. They were scanned with telescopes, drawn, discussed, and at last saluted with a ringing cheer. But we soon came to the conclusion that they were unfortunately no mountains, but merely the dark reflection of some lakes further to the east in the ice desert.

In my report of the expedition of 1870 I drew attention to a clayey mud which is found in circular cavities, from one to three feet in depth, on the surface of the inland ice, not only near the shore, but even as far inland as we reached on that occasion. My companion on that occasion, Prof. Berggren, discovered that this substance formed the substratum of a peculiar* ice-flora, consisting of a quantity of different microscopical plants (algæ), of which some are even distributed beyond the clay on the ice itself, and which, in spite of their insignificance, play beyond doubt a very important part in nature's economy, from the fact that their dark color far more readily absorbs the sun's heat than the bluish-white ice, and thereby they contribute to the destruction of the ice-sheet, and prevent its extension. Undoubtedly we have, in no small degree, to thank these organisms for the melting away of the layer of ice which once covered the Scandinavian peninsula. I examined the appearance of this substance in its relation to geology, and demonstrated:

1. That it cannot have been washed down from the mountain ridges at the sides of the glaciers, as it was found evenly distributed at a far higher elevation than that of the ridges on the border of the glaciers, as well as in equal quantity on the top of the ice-knolls as on their sides or in the hollows between them.

2. That neither had it been distributed over the surface of the ice by running water, nor been pressed up from the hypothetical bottom "ground" moraine.

3. That the clay must therefore be a sediment from the

* The altitudes were ascertained by comparing three aneroid barometers, while observation was simultaneously made at Egedesminde with a splendid sea barometer I had left there for that purpose. As the figures have, however, not yet been verified, they may be slightly altered. They seem on the whole too low.

* Lately described by Prof. V. Wittrock. "Om Snöns och Isens Flora, Särskildt i Arktiska Trakterna." Ur "A. E. Nordenskjöld, Studier och Forskningar föranledda af mina resor i höga Norden." (Stockholm, 1883.) See *Nature*, vol. xxviii., p. 304.

air, the chief constituent of which is probably terrestrial dust spread by the wind over the surface of the ice.

4. That cosmic elements exist in this substance, as it contained molecules of metallic iron which could be drawn out by the magnet, and which under the blowpipe gave a reaction of cobalt and nickel.

Under these circumstances the remarkable dust which I have named "kryokonite," *i. e.*, ice dust, obtained a great scientific interest, particularly as the cosmic element, viz., the matter deposited from space, was very considerable. Even later students who have visited the inland ice have observed this dust, but in places surrounded by mountains from which it might with more probability have been washed down. They have, therefore, and without having examined Prof. Berggren's and my own researches of 1870, paid little attention to the same, while the samples brought home by Dr. N. O. Holst from South Greenland in 1880 were not very extensive.

But now Dr. Berlin brings home from a great variety of places ice algæ, which, I feel convinced, will contribute fresh materials to our knowledge of the flora of the ice and snow. For my own part I have re-examined my first researches of the kryokonite, and they are fully corroborated. Everywhere where the snow from last winter has melted away, a fine dust, gray in color, and, when wet, black or dark brown, is distributed over the inland ice in a layer which I should estimate at from 0·1 to 1 m.m. in thickness if it was evenly distributed over the entire surface of the ice. It appears in the same quantity in the vicinity of the ice border surrounded by mountains as a hundred kilometers inland, but in the former locality it is mixed with a very fine sand, gray in color, which may be separated from the kryokonite. Further inland this disappears, however, completely. Gravel or real sand I have never, in spite of searching for them, discovered in the kryokonite. The kryokonite always contains very fine granular atoms, which are attracted by the magnet, and which, as may be demonstrated by grating in an agate mortar and by analysis under the blowpipe, consist of a gray, metallic element, viz., nickel iron. In general the dust is spread equally over the entire surface of the ice ; thus it was found everywhere where the snow from the previous year had melted away, while, to judge by appearances, there seemed to be little difference between the quantity found near the coast and in the interior. The dust does not, however, form a continuous layer of clay, but has, by the melting of the ice, collected in cavities filled with water, which are found all over the surface. These are round, sometimes semicircular, one to three feet in depth, with a diameter of from a couple of millimeters to one meter or more. At the bottom a layer of kryokonite one to four millimeters in thickness is deposited, which has often, by organisms and by the wind, been formed into little balls, and everywhere where the original surface of the ice has not been changed by water-currents the cavities are found so close to each other that it would be very difficult to find a spot on the ice as large as the crown of a hat, free from them. In the night at a few degrees below freezing point, new ice forms on these hollows, but they do not freeze to the bottom even under the severest frost, and the sheet which covers them is never strong enough to support a man, more particularly if the hole is, as was the case during half our journey, covered with a few inches of newly-fallen snow.

The kryokonite cavities were perhaps more dangerous to our expedition than anything else we were exposed to. We passed, of course, a number of crevasses without bottom, as far as the eye could penetrate, and wide enough to swallow up a man, but they were "open," *i. e.*, free from a cover of snow, and could with proper caution be avoided, and the danger of these could further be minimized by the sending of the two men sledges in front, and if one of the men fell into the crevasse he was supported by the runners and the alpenstock, which always enabled him to get up on the ice again. But this was far from being the case with the kryokonite hollows. These lie, with a diameter just large enough to hold the foot, as close to one another as the stumps of the trees in a felled forest, and it was therefore impossible not to stumble into them at every moment, which was the more annoying as it happened just when the foot was stretched for a step forward, and the traveler was precipitated to the ground, with his foot fastened in a hole three feet in depth. The worst part of our journey was four days outward and three days of the return, and it is not too much to say that each one of us during these seven days fell a hundred times into these cavities, viz., for all of us 7000 times. I am only surprised that no bones were broken, an accident which would not only have brought my exploration to an abrupt close, but might have had the most disastrous consequences, as it would have been utterly impossible to have carried a man in that state back to the coast. One advantage the kryokonite cavities had, however, viz., of offering us the purest drinking water imaginable, of which we fully availed ourselves without the least bad consequences, in spite of our perspiring state.

On July 16 we covered thirteen, on the 17th eighteen and a half, and on the 18th, seventeen and a half kilometers. The country, or more correctly the ice, now gradually rose from 965 to 1213 meters. The distances enumerated show that the ice became more smooth; but the road was still impeded by the kryokonite cavities, whereas the rivers, which even here were rich in water, became shallower, but stronger, thus easier of crossing. Our road was, besides often cut off by immense snow-covered crevasses, which, however, did not cause much trouble.

On the night of the 18th, when arrived at camp No. 14, the Lapp Anders came to me and asked if he might be permitted to "have a run," viz., to make a reconnaissance on "skidor"* to see if there was no "land" to the east. This granted, he started off without awaiting supper. He came back after six hours' absence, and reported that he had reached 27 kilometers further east, that the ice became smoother, but was still rising, but there was no sign of "land." If his statement was true, he had, after a laborious day's journey, in six hours covered about sixty kilometers ! At first I considered his estimate exaggerated, but it proved be perfectly correct. It took us thus *two whole* days to reach as far as he had got, as shown by the track in the snow. I particularly mention this occurrence in order to show that the Lapps really did cover the estimated distance of their journey eastward, of which more below.

During these days we passed several lakes, some of which had the appearance of not flowing away in the winter, as we found here large ice blocks several feet in diameter, screwed up on the shore, which circumstance I could only explain by assuming that a large quantity of water still remained here when the pools about became covered with new ice. The lakes are mostly circular, and their shores formed a snow "bog" which was almost impassable with the heavy sledges.

On July 19, we covered seventeen and a half, on the 20th sixteen and a half, on the 21st, seven, and on the 22d seven and a half kilometers (15th to 18th camp), The ice rose between them from 1213 to 1492 meters. The distances enumerated fully show the nature of the ice. It was at first excellent, particularly in the morning, when the new snow was covered with a layer of hard ice; but on the latter days we had great difficulty in proceeding, as a sleet fell with a southeast wind in the night between the 20th and the 21st. The new snow, as well as that lying from the previous year, became a perfect snow bog in which the sledges constantly stuck, so that it required at times four men to get them out. We all got wet, and had great difficulty in finding a spot on the ice dry enough to pitch the tent. On the 22d, we had to pitch it in the wet snow, where the feet immediately became saturated on putting them outside the India-rubber mattresses. A little later on in the year, when the surface of the snow is again covered with ice, or earlier, before the thaw sets in, the surface would no doubt be excellent to journey on.

When we, therefore, on July 21, were compelled to pitch the tent in wet snow, as no dry spot could be discovered, and it was impossible to drag the sledges further, I sent the Lapp Lars Tuorda forward on "skidor" to find a dry road. He came back and stated that the ice everywhere was covered with water and snow. For the first time in his life he was at a loss what to suggest. It being utterly impossible to get the sledges further, I had no choice. I decided to turn back.

I wished, however, to let the Lapps go forward some distance to the east to see the country as far as possible. At first I considered it advisable to let their journey only last twenty-four hours, but as both Anders and Lars insisted that they were most eager to find the "Promised Land," and said they could do nothing toward discovering it in that short period, I granted them leave to run eastward for four days and nights, and then return.

On leaving I gave them the following written orders:

"Instructions for Lars and Anders' "skid" run on the inland ice of Greenland, viz.:

"Lars and Anders have orders to proceed on skidor eastward, but are allowed to alter the course, if they may deem it advisable, to north or south.

"At the end of every third mile the barometer shall be read and the direction run noted.

"The absence is to be four days, but we will wait for six days. After that, viz., on the morning of July 28, we return. If not returned, we leave behind in a sledge provisions, brandy, mattresses, etc.

"Lars is warned not too be too bold. Should land be reached, you are to collect as much as you may gather of blossoms and grass, if possible several kinds (specimens) of each.

"Given on the inland ice in Greenland, July 21, 1883.

"A. E. NORDENSKJOLD."

They were allowed to select what provisions, etc., they desired, and were furnished with two compasses, aneroid barometers, and a watch.

At 2:30 A.M. on July 22 they started. The days we waited for them were generally spent in the tent, as water surrounded us everywhere. The sky was covered with a thin veil of clouds, through which the sun shone warmly, at times even scorchingly. From time to time this veil of clouds, or haze, descended to the surface of the ice and hid the view over the expanse, but it was, remarkably enough, not wet but *dry*, yes, so dry that our wet clothes absolutely dried in it. We have, therefore, I consider, witnessed a phenomenon on the inland ice of Greenland which is related to the "sun smoke" phenomenon of Scandinavia, viz., what Arago has described under the name "brouillard sec."

On the 24th, after an absence of fifty-seven hours, the Lapps returned. It was the want of drinking water and fuel which compelled them to return. The surface had been excellent for their journey, and they had covered a distance out and back of 230 kilometers, an estimate which I consider perfectly reliable. During the march forward the barometer was read every third hour. It gave the point of return a height of 2,000 meters.*

As to the run, Lars rendered the following report: When they had reached thirty miles from the camp no more water could be found. Further on the ice became perfectly smooth. The thermometer registered—5° C. It was very easy to proceed on the "skidor." At the point of return the snow was level and packed by the wind. There was no trace of land. They only saw before them a smooth ice covered by fine and hard snow. The composition of the surface was this—first four feet of loose snow, then granular ice, and at last an open space large enough to hold an outstretched hand. It was surrounded by angular bits of ice (crystals). The inland ice was formed in terraces—thus, first a hill, then a level, again another hill, and so on. The Lapps had slept for four hours, from twelve midnight on July 23, in a hollow dug in the snow, while a terrific storm blew. They had till then been awake for fifty-three hours. On the first day there was no wind, but next day it came from the south, and lasted thus until twenty-four miles on the return journey, when it changed to west. On the return journey, when forty miles from our camp, two ravens were seen. They came from the north and returned in the same direction. The Lapps had for a moment lost the track of the "skidor" in the snow. The ravens flew at first, they found, parallel with the track, and then returned to the north.

On July 25 we began the return journey. It was high time, as the weather now became very bad, and it was with great difficulty we proceeded in the hazy air between the number of crevasses. The cold, after the sun sank below the horizon at night, also became very great; and on the morning of July 27 the glass fell to —11° C.

As to the return journey I may be very brief. The rivers now impeded us but little, as they were to a great extent dried up. The ice knolls had decreased considerably in size too, and lay more apart, but the glacial crevasses had greatly expanded, and were more dangerous, being covered with snow. Even the cavities and the glacial wells, of which many undoubtedly leave a veritable testimony of their existence behind them in the shape of corresponding hollows in the rock beneath, had expanded and increased in number. On a few occasions, on the return journey, we saw flocks of birds, most probably water fowl, which were returning from the north.

On July 31 we again sighted land, which was reached on the afternoon of August 4, and proceeded to "Sophia Harbor," where Esquimaux were, as arranged, waiting for us. For convenience' sake I now divided our party into two, one of which sailed in the lifeboat Sophia to Egedesminde, where the steamer was to take us on board, and the other, in which was myself, marched to that place across the low but broad promontory which separates Tessiusarsoak and South-East Bay, and then in two Esquimaux "Kone" boats to Ikamiut and Egedesminde.

On August 16 the Sophia arrived from the north, embarked us, and made for Ivigtut, where we arrived on the 19th.

On the expedition carried out under Dr. Nathorst during my absence he will himself make a report, and I have no doubt that the results of the same will prove very important. Particularly will the very rich collections of fossil plants, which he has made with the greatest regard to the geological condition of the strata, be of great value to science, as they will furnish us with many new materials and detailed illustrations of the flora of the Far North during the epoch when forests of fig trees, cycadi, ginko, magnolia, and tulip trees covered these regions. Dr. Forsstrand and Herr Kolthoff's collections and studies of the fauna of Greenland will also contribute to extend our knowledge of the naturalistic conditions of the Arctic regions, while the careful researches made by Herr Hamberg of the saltness, composition, and temperature of the sea will, I am sure, greatly benefit hydrography. His researches have been effected in Davis Strait and Baffin's Bay too, the hydrographical conditions of which are but little known.

With regard to the results of my exploration of the inland ice, I may be permitted to say a few words. That we found no ice-free land in the interior, or that it does not exist between 68° and 69° lat. in Greenland, is due directly to the orographical conditions which exist in this part of the country, as referred to in my programme of the expedition. The land has here the form of a round loaf of bread, with sides which gradually and symmetrically slope down to the sea, *i. e.*, exactly the shape which I then pointed out was a necessary condition if the entire country should be covered with a continuous sheet of ice.

But, thanks to the Lapps, my expedition is the first which has penetrated into the very heart of the enormous Greenland continent, and which has thus solved a problem of the greatest geographical and scientific importance. It is the first exploration of the hitherto unknown interior of Greenland, the only continent in the world into which man had not penetrated.

A new means of locomotion, the "skidor," seems also to have been acquired for the Arctic explorer of the future, which may greatly assist him in his work, and enable him to reach places hitherto deemed impossible of approach, but of the use of which the Lapp seems to possess, so to speak, the monopoly.

At Ivigtut, a visit was made to a valley which, on account of its copious flora, has been named Gronnedal (Green Valley), and another to the spot where the inland ice falls into the Arsukfiord. In the former place Dr. Nathorst found, in a kind of syenite, a blue mineral which seems to be sodalite. This discovery is chiefly remarkable from the circumstance that this mineral is also found in the vicinity of the small kyrolite deposit at the Ilmen mountain in the Ural, which seems to indicate that a kind of relation exists between these two minerals, both strong in natron, which circumstance may be of service to the geologist in search of kyrolite. From the excursion to Gronnedal Herr Kolthoff brought with him some rare butterflies and other insects, while of the botanical finds there were splendid specimens in bloom of *Linnæa borealis*, which is quite plentiful about Ivigtut. It has not before been known to exist in Greenland. The zoologists found only three kinds of land mollusks, viz., a physa, a vitrina, and a helix, which were all few in number. The entomological harvest consisted of a few beetles, butterflies, and insects of other kinds.

On their way to Julianehaab, as they steamed down the narrow fiord in pitch darkness and a perfect calm, "we saw suddenly behind the vessel on the surface of the sea a broad but clearly defined band of light. It shone with a steady, yellowish light, somewhat like that of phosphorescent elements, while, in spite of the speed maintained, viz., four to six knots, the band came nearer and nearer. When it reached the ship it seemed as if we were steaming through a sea of fire or molten metal. After a while the light traveled beyond the vessel, and we saw it at last disappear on the horizon. Unfortunately I had not an opportunity of examining it with the spectroscope. It was beyond doubt of a different nature to the bluish-white phosphorescent light, which throughout its appearance was seen distinctly in our wake; and as the light was perfectly steady it cannot have been caused by the phosphorence from a passing shoal of fish. A shoal of fish would have occasioned some stir in the sea, but in this case the surface was calm throughout, while phosphorescence from the same would have been bluish in character, not yellow as this was. The Esquimaux stated that a glacier river in the vicinity shed a thin layer of brackish clay-water over the surface of the fiord, and fancied that this circumstance was in some way or another connected with this grand phenomenon, which they themselves had never before witnessed. There was at the time no aurora visible, the sky being covered with clouds. The cause of this remarkable phenomenon, which made the Sophia seem to steam through a sea of fire for fully fifteen minutes, I have been unable to ascertain; may be it was a phenomenon such as that which made Lig-Lodin, of the Greenland Saga, relate to King Harald Sigurdson that he had once sailed over a spot where the sea was on fire.

At Fredriksdal Nordenskjold engaged two Esquimaux to act as pilots in the sounds of the east coast, north of Cape Farewell. One of them stated that remains of buildings, which were not built by the Esquimaux, are to be found in nearly every great fiord on the east coast, particularly in the large ones of Umanak, Ekalemiut, and Igdluluarsiut. Entire walls do not remain standing, but though low they are extensive. The largest ruin is said to exist at Igdluluarsnit. A fine kind of soft stone is to be found on an island south of Umanak, from which pots were made to three feet in diameter. This mineral deposit is of special interest in reference to the ethnography of Greenland, as the Umanak fiord is situated in lat. 63°. This name is, however, a common one for places among the natives. Ivar Baardsen, in his famous description of Greenland, states that a soft stone was found on Reno, outside the Eina fiord, from which the largest vessels were made. Cannot the mineral deposit at Umanak be identical with this? These statements, as well as many others received from the "Eastlanders," and the

* The Swedish "skido" and Nowegian "Ski" are long strips of pine wood slightly bent at the top, polished and as elastic as if they were of the finest steel, with a strap for the feet in the center, on which the Lapps and Scandinavians run on the snow with remarkable agility at a tremendous pace.—ED.

* I have as yet been unable to verify the barometer calculations, and the figures stated here may suffer some nodification.

remarkable Norse characteristics possessed by the same, which the missionary Hans Egele pointed out long ago, seem to Baron Nordenskjold to refute the theory now mostly advanced as to the Norse Colonies, viz., that they were situated on the southwest coast of Greenland.

In spite of predictions of failure and even disaster before he left Europe, Nordenskjold decided to attempt to land on the east coast, south of the Artic circle. After some difficulty they succeeded in anchoring in the Kangerlutsiok Bay, but on account of the state of the ice they had to stand to sea again, and steamed along the ice-belt lining the coast, in order to find an opening by which the shore might be reached. The fauna of the sea here was very poor, and they only saw in two days one whale, a few seals, and a very small number of sea birds. The abundant fauna of the coasts of Spitzbergen and Novaya Zemlya is thus entirely wanting on the east coast of Greenland. The cause of this may be the great depth of the sea right up to the shore, which prevents the animals from fetching their food from the bottom; perhaps also the war of extirpation which the natives seem to have carried on for years has also contributed thereto. The auk and the *Uria grylle* are, however, said to breed in large numbers on the rocks off Cape Farewell. The Esquimau pilot stated that he had been told by old people that they could remember the *Alka impennis* having been found here. The natives called it Isarokitsok. Only a little distance out to sea they found a warm current—rising to 6° C.—coming from the south. The drift ice was what Arctic skippers call "knatteris," *i. e*, little bits, viz., remains of large floes after the influence of the summer heat and the Gulf Stream. Very few icebergs were seen, and they appear to be far more numerous on the west coast. As it was now late in the season, and the coals were nearly done, Nordenskjold had reluctantly to renounce the plan of reaching the fiords where the greatest ruins are said to exist, and, instead, attempt to reach the south shore by Cape Dan, a promontory which, if the Einafiord was situated at Umanak or Ekaleumiut, should be the Herjolf's Naze of the Sagas. "On the 4th, when off the Cape, we met the ice twenty miles from the coast, which was, however, passable, as it consisted mostly of large, loose floes only a few feet above water, while nearer the shore it again became heavier. Beyond this we saw an ice-free channel three to four miles wide. The sea was as smooth as a pond, and a boat could easily reach the shore. The mountains ran mostly into the sea with almost perpendicular declivities, without any grass covered underland. Opposite us we saw a small bay, into which I steamed, in order to take the sun; but finding both the depth and the bottom unsuitable for anchoring, we only landed for a few hours, while some of the crew went on the hills above to look for a better harbor. The staff returned on board with a rich harvest from the steep slopes, the flora of which was curious beyond expectation. The sailors reporting a harbor near, I steamed thereto and cast anchor. It was a beautiful fiord, with several arms, which was only connected with the sea through a small opening, and was well sheltered. It was the first harbor on the east coast south of the Polar circle in which a vessel had anchored for several centuries.* If Cape Dan is the old Herjolf's Naze, this harbor is the 'Sand' described by Ivar Baardsen, 'much frequented by the Norwegians and traders.' That the Norwegians had once been here was demonstrated by walls of loose stone erected on the mountains above the harbor, which had, no doubt, served as landmarks for finding the almost hidden opening of the fiord. We found, besides, some stone ruins of a smaller house, identical with those found on the west coast. These ruins are, of course, not extensive enough to demonstrate that there was situated one of the 'Bygder' (parishes) of Greenland, but they may certainly serve as sign posts for future explorers of the east coast. As soon as at anchor we went on shore, and spread in all directions in order to examine the neighborhood. King Oscar's harbor is surrounded by soft, close grass slopes and flourishing shrubs. The fauna appeared to me more copious and the grass less mixed with moss than on the west coast in the same latitude. In one of the valleys a river flowed, the shores of which consisted of loose sand without any covering of grass. Here was found traces of the Esquimaux. Some of the footprints were days old, but others were so fresh that the moist sand had not had time to dry. Most probably they had taken flight on seeing the steamer forcing the barrier which had hitherto formed their shelter. We found plenty of remains of them in the shape of huts, graves, fox pits, etc. The naturalists gathered here a quantity of fresh materials of the fauna and flora of East Greenland, among which I may specially mention the well-known *Potentilla anserina*, which is found so often near the Norse ruins in West Greenland, and which may, for that same reason, be a sign of the Norse colonization of East Greenland. We found traces of reindeer, but none of the musk-ox; neither did we see any bears or walruses, and only a few seals. Our whole bag was two ptarmigans. That the Esquimaux had decamped was very annoying; as they could no doubt have given some valuable information relating to this part of Greenland and the tribes which inhabit it."

After reconnoitering the coast still further, Baron Nordenskjold decided that his best course was to return at once to Reikjavik. Before doing so, however, some hours were spent in dredging and in hydrographical research, as well as in photographing some of the coast scenery.

"Having thus given an account of the work of my expedition, I have to point out that we have been the first to penetrate into the heart of Greenland, and that our journey has resulted in learning something about this continent, the natural conditions of which may probably give us a clew to the true condition of Scandinavia during the Glacial period, the study of which is therefore of such great importance to the geology of North Europe. Besides this, valuable scientific data have been collected during my voyage along the east coast of the composition of the ice belt which bars the way *from the east* to the southern part of Greenland, while many errors as to the state of the east coast of Greenland have been corrected. In addition to these objects one more has been attained, viz., the anchoring of a vessel by the shore of East Greenland, an achievement attempted in vain for centuries. If thus the work of the numerous expeditions dispatched since the sixteenth century by sea to the part of Greeland lying opposite or south of Iceland to the part where the Norse Osterbygd was or was not situated, it will be found that not one of them succeeded in reaching the coast.

"A few more words in conclusion as to the purely scientific results of the expedition. During the voyage of the Sophia along the coast of Greenland from Cape Dan past Cape Farewell to Cape York, and further from Cape York around Cape Farewell to Ingolf's Mountain, hydrographical researches and dredgings were effected whenever time and weather would permit. These labors were conducted by Herr Hamberg and Dr. Forsstrand. In addition, Herr Hamberg effected a number of analyses of sea water, and the gases contained therein, from various depths, while he brings home a series of the most carefully effected measurements of the temperature of the sea, which demonstrate that the *cold current* running along the east coast is, both in width and depth, very insignificant, and rests *even near the shore* upon one of warm water produced by the Gulf Stream. Davis Sound and Baffin's Bay, on the other hand, are filled with cold or very slightly warmed water *to the bottom.* Contrary, therefore, to the general belief, *the west coast of Greenland is washed by cold water, while a greatly heated current coming from the south runs along the east coast a distance of 40' to 50' only from the shore.* This current must exercise a great influence upon the climate of the east coast, which may be more moist, but, I believe, not colder than that of the west coast.

"The dredgings have yielded Dr. Forsstrand a fine harvest of of marine animals, etc., of which I may mention gigantic sponges from great depths in Denmark Sound (between Iceland and Greenland). The dredgings on the east coast were, however, impeded through causes detailed above, and by the circumstance that the bottom consists mainly of huge bowlders, which tore the net. Of the animal species existing on land or in fresh water, Herr Kolthoff has collected rich fresh materials of the Greenland fauna. Especially will the variety of insects collected be of great instructive value to science. On account of the limited accommodation on board, and from the circumstance that the flora of Greenland is well known through Danish and Swedish specialists, I took no botanist with me. But even in this field new materials have been gathered through the zeal given to such researches by Dr. Nathorst and Dr. Berlin whenever time permitted. The collections of microscopical plants which have been made. the true place of existence of which is the ice and the snow, must particularly be of great value. They are besides of additional interest to the expedition, as they belong to a new branch of science which has in the first instance been created by Swedish *savants.* The collections, perhaps, of most value to science have, however, been made by Dr. Nathorst from the Northwest Greenland so-called basalt formation, which is remarkable for the quantity of fossil plants contained in the clay, sand, and tuff strata there. Of course some very fine palæontological collections have been brought from these parts before, especially by the Swedish expedition of 1870, and by some Danish ones under Dr. K. Steenstrup; but it is the first time that a palæontologist has visited this spot, and I am, in consequence, convinced that the objects gathered by Dr. Nathorst, when scientifically treated, will yield many new data on the copious flora which once covered the ice-laden regions around the Pole.

"Finally, the expedition has brought home some splendid specimens of the remarkable minerals found at the well known deposits at Kangerdluarsuk and at Ivigtut, while I have on the inland ice collected, as previously stated, a great many samples of the dust found on the ice, and which I have named kryokonite. I hope, when this has been exhaustively analyzed, to be able to furnish fresh proofs in support of the theory that this deposit is, at all events partly, of cosmic origin, and thereby contribute further materials to the theory of the formation of the earth. Dr. Nathorst was, as previously stated, prevented by the ice from reaching Cape York and examining the blocks of ironstone lying there, but their existence has been corroborated beyond doubt by the Esquimaux in the neighborhood. Here the expedition obtained some valuable ethnographical objects, and it learnt a fact from the natives which may be of considerable importance as to the question of the wanderings of the tribes around the Pole, viz., that four 'Russian Esquimaux' had come to Wolstenholme Sound. They said they were the last survivors of a tribe which had left their place of habitation by the Behring Strait (or the northern shore of Asia?) in search of a new place of settlement, and who had at last reached Smith's Sound. These are the results of my expedition to Greenland in the Sophia. The scientific collections made will be distributed among the museums of my country.

A. E. NORDENSKJOLD.

We are enabled to supplement Baron Nordenskjold's report by the following account, furnished to us by another member of the expedition, of the visit paid to the remarkable Igaliko ruins:

On August 24 the Sophia steamed to Igaliko, at the bottom of the fiord of the same name. The object of this visit was to examine the ancient Norse ruins which are found here. Those who thus believe that the "Osterbygd" of Greenland was situated in this part assert that the ruins of Igaliko are nothing more nor less than those of Erik Röde's own mansion "Brattelid." However that may be, the Norseman who selected this spot for his residence acted very wisely. The ruins are situated at the very bottom of the fiord, where the absence or presence of the ocean ice on the coast affects the climate but little. The vegetation in this spot is, in consequence, quite luxuriant. Thus a vaginal plant, *Lathyrus maritimus*, grows here in such abundance that it reminds one of a field of peas, while *Ranunculus acris* attains a height of two feet, and *Campanula rotundifolia*, the bluebell, along with various grasses, flourish in great profusion. In the pools Menyanthes and Potamogeton thrive, while copses of birch trees and willows offer excellent fuel. There are also plenty of wild berries. The ruins, the walls of which were formed of enormous blocks of sandstone, lie just below a table-shaped ridge of sandstone by the side of a crystal brook, copiously encircled by *Alchemilla vulgaris* and watercress. The spot is, in fact, one which would fully justify the name given to the country. At the time of our visit about a dozen cows were fed here, whose excellent milk we tasted, while in the beds around the huts of the natives swedes and potatoes grew luxuriantly, the former having attained the size of large apples. It certainly was strange to view this spot, and we naturally asked each other, What has become of the old Norsemen who once peopled it? It is impossible to believe that they were extirpated or conquered by the Esquimaux. It seems far more probable that both races have commingled, an assumption further corroborated by the strange circumstance that Esquimaux are found in this tract who have never been in contact with the Danes, but who nevertheless possess features of pure Norse character.

* North of the Polar circle the east coast of Greenland is in many places easily accessible.

WHITE birch bark oil is said to be the article which gives to Russia leather its peculiar aromatic and lasting qualities, and when dissolved in alcohol is said to be excellent for preserving and waterproofing fabrics. It renders them insect-proof, and does not destroy the pliability of the fabric.

DISCOVERY OF AN ANCIENT LENS.

SIR A. HENRY LAYARD, in his "Nineveh and Babylon," describes a lens which he found in the course of his excavations, and which is now in the British Museum. By the kind permission of Dr. Birch, the keeper of Oriental Antiquities, the *Journal* of the Royal Microscopical Society has been enabled to figure it. The lens is thus referred to by Sir A. H. Layard: "With the glass bowls was discovered a rock crystal lens, with opposite convex and plane faces. Its properties could hardly have been unknown to the Assyrians, and we have consequently the earliest specimen of a magnifying and burning glass. It was buried beneath a heap of fragments of beautiful blue opaque glass, apparently the enamel of some object in ivory or wood, which had perished.

A note from Sir David Brewster, quoted by Layard, ends as follows: "It is obvious from the shape and rude cutting of the lens that it could not have been intended as an ornament. We are entitled, therefore, to consider it as intended to be used as a lens, either for magnifying or for contracting the rays of the sun, which it does, however, very imperfectly."

OF the menhaden, found so abundantly on the Long Island and New England coasts, the catch during 1883 is given at 650,000,000, as against 346,000,000 in 1882. They are taken for their oil, as well as for the resulting pomace for fertilizing, but the less number of fish caught in 1882 were in better condition and gave more oil that the larger catch of 1883. The crude oil is now worth 45 cents a gallon.

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